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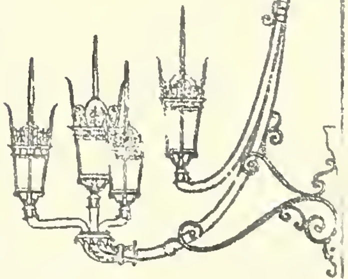

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HARVARD CLUB GARAGE

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DRAFT PROJECT IMPACT REPORT

February, 1991

PREPARED FOR:

The Harvard Club of Boston
374 Commonwealth Avenue
Boston, MA 02215-9990

PREPARED BY:

HMM ASSOCIATES, INC.
ENGINEERS, ENVIRONMENTAL CONSULTANTS & PLANNERS

DRAFT PROJECT IMPACT REPORT
FOR
THE HARVARD CLUB OF BOSTON

February 1991

Submitted by:

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I. Executive Summary

I. EXECUTIVE SUMMARY

1.0 INTRODUCTION

The proposed Harvard Club Garage project is subject to development review pursuant to Article 31 of the Zoning Code of the City of Boston. On July 5, 1989, the Harvard Club of Boston ("the Harvard Club") submitted a Project Notification Form (PNF) to the Boston Redevelopment Authority (BRA) for the construction of a parking garage. On August 24, 1989, the BRA issued a Scoping Determination (Appendix A) for the Draft Project Impact Report (DPIR) in response to the PNF. The scope required a description of the project, general information, a transportation systems component, urban design component, infrastructure systems component, historic resources component, and an environmental protection component, including an analysis of potential impacts in each of the following areas:

- Air Quality
- Solid Wastes
- Noise
- Water Quality and Resources
- Geotechnical/Hazardous
- Construction
- Rodent Control

2.0 SITE LOCATION AND PROJECT DESCRIPTION

The proposed Harvard Club Garage project is located in the Back Bay/ Kenmore area on the Newbury Street extension, west of Massachusetts Avenue. The block on which the garage will be located is bounded by Massachusetts Avenue, Newbury Street, Charlesgate East, and Commonwealth Avenue. Figure I-1 is a Site Location Plan. In addition to the Harvard Club, the majority of nearby buildings contain residential and/or office space. The site is adjacent to the Somerset Garage to the west and Windsor Place and the Harvard Club of Boston to the north and east.

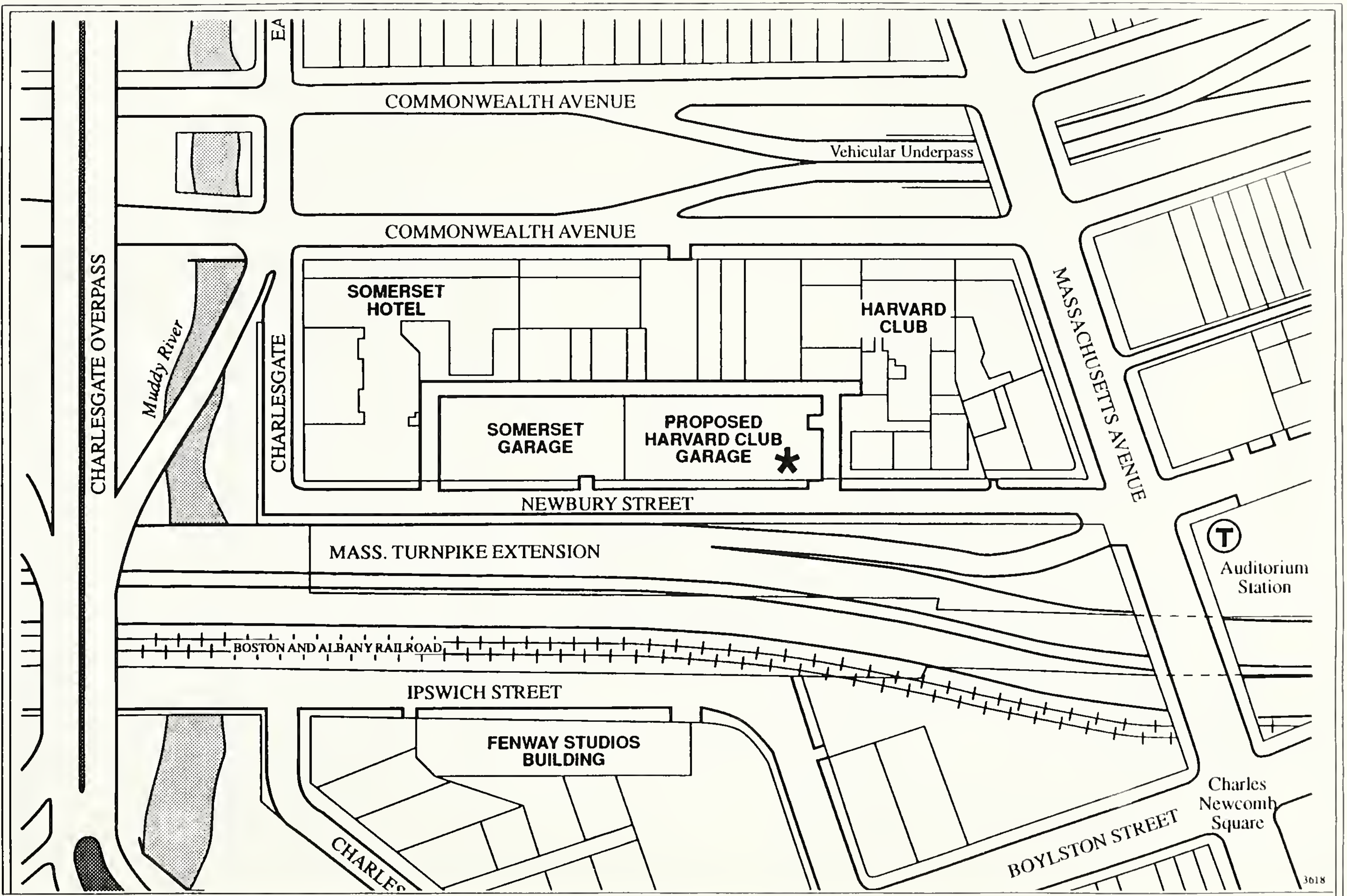

Figure I-1
Site Location Plan

The approximately 19,500 square foot site of the proposed garage is currently used as a surface parking lot for the Harvard Club. Upon completion, the site will include a 430-car, 157,000 square foot garage with 1½ levels below-grade and 6½ levels above-grade. The height will be approximately 65 feet with an FAR of 7. The design and detailing of the garage, which include red brick with light precast trim and corner towers, were, in part, drawn from the Fenway Studios building across the Massachusetts Turnpike. In addition, the slope of the ramps were also designed to be visually compatible with the Somerset Garage. The circulation patterns of the adjacent Somerset Garage are a mirror image of the circulation patterns of the proposed Garage. The exit/entrance of the proposed Harvard Club Garage, located on the eastern portion of the site, minimizes potential circulation conflicts with the Newbury Street exit/entrance of the Somerset Garage.

The two alternatives requested by the Scoping Determination were studied. Alternative 1 basically conforms to the Downtown IPOD and has 200 spaces on four floors. Alternative 2 is the proposed project with 430 spaces. Within Alternative 2, two space allocations were studied in the Transportation Component. Alternative 2A includes 140 spaces reserved for Club members, 100 short-term commercial spaces, and 190 monthly lease spaces. Alternative 2B includes 140 spaces reserved for the Club, 250 short-term commercial spaces, and 40 monthly lease spaces. Although a specific allocation of spaces has not yet been determined, it is likely that the allocation of spaces will fall between Alternatives 2A and 2B.

It is currently proposed that 100 spaces will be reserved for Back Bay residents, between 140 to 300 spaces will be used for the Club, and the remaining spaces will be used as short-term commercial spaces or club spaces depending on the time of day. The impacts of this alternative will fall between and be similar to the impacts described for Alternatives 2A and 2B. A portion of the commercial spaces will likely be used by the Eliot Hotel which is becoming more of a "residential/suite" hotel.

The Club's membership has grown steadily over the past several years. It is anticipated that the Club membership will rise to 9,000 by 1995. With the Back Bay's existing parking shortage, an increase in the number of vehicles in the Back Bay as a result of an increased number of condominiums, and the cutback of public spaces at the adjacent Somerset Garage, the need for parking in the area has increased.

Club members and function attendees wait in line at the Newbury Street entrance to the existing lot, creating a queue on Newbury Street which sometimes extends beyond Newbury Street. During larger functions, members are often not able to part at the existing lot, forcing them to circle the area, thereby adding more traffic to Back Bay streets.

Development of the garage will not only address the parking needs of the Club, but will also address the growing need for residential and commercial Back Bay spaces, particularly in light of the loss of public spaces at the Somerset Garage. In addition, the garage will decrease the queues and circling in the vicinity of the project.

The Club will continue to meet with the abutters to ensure that the proposed garage is beneficial to the City, the abutters, and the Club.

Based on an extensive design review process, numerous community meetings, and meetings with the BRA, the Harvard Club has studied an alternative in an effort to mitigate any adverse impacts of the garage, which includes a 4-story notch cut into the corner of the proposed parking facility. The notch has been proposed to open up light and views to the third floor pool deck at 380-390 Commonwealth Avenue and the living units adjacent to the pool. The notch will also result in a reduction of 19 to 23 parking spaces.

3.0 SUMMARY OF IMPACTS

The following sections summarize the potential benefits and impacts of the proposed Harvard Club Garage project. The environmental impacts described are primarily the same for each of the alternatives as explained in the Environmental Protection Component.

3.1 Public Benefits

Construction of the Harvard Club Garage provides numerous benefits to the area in many ways, including:

- Traffic benefits from reduced circling and queuing.
- Increased annual real estate taxes to the City of Boston.
- Construction jobs.
- Better awareness of public transportation and car-pooling options by Club members through the formation of a Harvard Club Transportation Committee.
- Streetwall completion on Newbury Street.
- Parking spaces to Club members.

- o Parking spaces to area residents.
- o Short-term parking spaces for area visitors.
- o A project which is beneficial to the City, abutters, and the Club.

Voluntary Contribution

The Harvard Club proposes to make a voluntary contribution to the Back Bay Transportation Management Association (of which they are a member) or to an entity chosen by the BRA.

3.2 Transportation

The proposed garage will result in traffic benefits including a reduction in queuing on Newbury Street and circling in the area. The location of the ticket booth and the ability to self-park reduces the existing queue on Newbury Street. The proposed elimination of the metered parking spaces along Newbury Street also improves traffic flow along Newbury Street. In addition, the proposed garage also reduces circling by allowing the Harvard Club to meet its parking needs on-site without having to turn away member and guest vehicles, thereby eliminating the need to circle the area in search of a parking space.

The traffic analysis showed that there will be no changes in Level of Service (LOS) at any of the intersections under either of the Build alternatives studied.

3.3 Air Quality

The air quality analysis was performed to show the impact on air quality of the proposed Harvard Club Garage. Areas of human activity (sensitive receptors) exposed to maximum air pollutant levels from motor vehicle emissions were identified in the project area. Using air quality modeling techniques, carbon monoxide (CO) levels were estimated at these sensitive receptors under the Build and No-Build cases and compared with Massachusetts and National Ambient Air Quality Standards (NAAQS).

The air quality analysis was based on a modeling protocol developed in coordination with and approved by the Boston Redevelopment Authority. The Massachusetts Department of Environmental Protection supplied estimated levels of "background" air quality as well as recommended procedures for calculating maximum one-hour and eight-hour CO concentrations at sensitive receptors located adjacent to three key intersections in the project area. These procedures included modeling the key intersections of the project area using EPA Mobile 4 and CAL3QHC computer programs to calculate motor vehicle emission and CO concentrations at intersections.

The cumulative results of the intersection analysis, parking garage impacts, and background levels at each receptor are detailed in the report. Predicted concentrations represent the highest concentrations that could potentially exist during the simultaneous occurrence of worst case meteorology and peak traffic. Typical pollution levels are expected to be lower than these worst case values.

The air quality analysis for the proposed Harvard Club Garage project demonstrated no new or increased exceedances of the NAAQS for CO at any location. Of the three intersections in the study area, two - Massachusetts Avenue/Commonwealth Avenue and Commonwealth Avenue/Charlesgate East - have predicted maximum levels in exceedance of the eight-hour NAAQS for CO in both the Build and No-Build cases. At both intersections, however, the analysis demonstrates that the exceedances are the same with or without the proposed project showing that the project has no impact on air quality. All maximum concentrations in the 1994 study year are predicted to be lower than the existing year due to improvements in emissions in the overall vehicle fleet.

3.4 Solid Waste

The proposed Harvard Club Garage project does not require any demolition and, therefore, solid waste during construction is expected to be minimal. Disposal of construction debris will continue throughout the construction period to prevent the accumulation of debris on-site. As a garage, the Harvard Club Garage will not generate much operational waste. Any waste generated will be removed by independent contractors with the trash generated by the Harvard Club.

3.5 Noise

The noise analysis included a two-part study undertaken to determine the potential noise impacts of the proposed project. To quantify to potential noise effects resulting from increased garage traffic on Newbury Street, an assessment was conducted using the

Stamina 2.0 Noise Model.* The analysis indicated that Newbury Street is only a minor contributor to noise levels in the project area. Noise from the Turnpike clearly dominates the existing noise environment. Based on the projected future No-Build and Build traffic volumes, an estimate of the noise contribution of traffic on Newbury Street at each receptor location was made for the future conditions. The increase in noise from Newbury Street will still have no effect on the overall noise levels at each receptor.

3.6 Water Quality and Resources

The site of the proposed Harvard Club Garage is served by separate sanitary sewer and storm drains. These systems convey sanitary sewage to the Deer Island Wastewater Treatment Plant and storm drainage to the Charles River. There is presently no stormwater discharge from the project site to the Muddy River and there will also be no discharge to the Muddy River after development.

Stormwater flows from the project site are not anticipated to change appreciably as a result of the development of the garage. The site is presently impervious and will continue to be so after development. In order to protect water quality, stormwater will be discharged to the storm drain system after passing through an oil/water separator. The separator will prevent oil and gasoline from entering the storm drain system which may actually improve water quality.

3.7 Hazardous Waste/Geotechnical

A subsurface analysis will be conducted prior to the Construction Management Plan (CMP) and issuance of a building permit. The subsurface investigation will determine the possibility of any contaminated soil and groundwater. If any exists, it will be removed in accordance with the applicable regulations. The analysis will also aid in determining the appropriate foundation construction methodology to minimize ground movement and settlement during excavation, and any potential impact on adjacent buildings. Appropriate and specific monitoring measures, performance criteria, and potential plans for remedial measures will be determined as part of the CMP. Contractors will be required to submit operations manuals outlining mitigation measures.

---

* Stamina 1.0/BCR. Federal Highway Administration, Version 3, Traffic Noise Prediction Model. March 1983.

3.8 Construction

A Construction Management Plan will be approved by the Boston Transportation Department (BTD) prior to issuance of the building permit. The Plan will be in compliance with the BTD's Construction Management Program and the DPIR. The designated contractor will be bound by the agreement.

The construction period for the proposed Harvard Club Garage project is expected to last approximately eight months, from June 1991 through January 1992. Typical construction hours for the project will be from 7:00 AM to 3:30 PM, Monday through Friday and occasionally on Saturday.

In determining scheduling, truck routes, and staging locations for the proposed Harvard Club Garage project, particular attention will be given to ensure the protection of nearby residential and commercial streets. Each stage of construction will have minor truck and pedestrian traffic impacts since the proposed garage is located on the Newbury Street extension where there is little pedestrian and automobile activity, thus limiting potential impacts.

3.9 Rodent Control

The Harvard Club or its contractor will contract with a licensed exterminator prior to beginning any work at the project. Rodent extermination will be carried out before, during, and at the completion of all foundation work for the Garage, in compliance with City and State requirements. Rodent extermination prior to work start-up will consist of treatment of areas throughout the project area, including alleyways, surrounding building exteriors, and building interiors. During the construction process, regular service visits will be made in order to maintain effective rodent control levels.

3.10 Urban Design

The proposed Harvard Club Garage completes the streetwall on Newbury Street, is compatible with the Back Bay Historic District, and adds color and excitement to the street. Brick and mortar colors and the detailing on the upper spandrel, column and tower parts were derived from the Fenway Studios building across the Massachusetts Turnpike and the Harvard Club.

3.11 Historic Resources

As requested in the Scoping Determination issued by the Boston Redevelopment Authority, the Historic Resources Component includes a description of the historic resources located near the proposed Harvard Club Garage. The proposed garage is located within the Back Bay Historic District and near the Hotel Somerset and the Puritan Hotel. The project is also located across the Massachusetts Turnpike from the Fenway Studios building which is on the National Register of Historic Places. Through the appropriate use of materials, height, and massing, the proposed Harvard Club Garage has been designed to ensure its compatability with and minimize its impacts on nearby historic resources.

3.12 Infrastructure

Because of the size and use of the proposed project, the impacts on local infrastructure systems is expected to be minimal. The proposed Harvard Club Garage is not expected to require any consumptive water use and, therefore, the garage is anticipated to have negligible impact on the existing supply of water in the vicinity of the project.

Much of the site runoff will consist of roof runoff which is typically considered "clean" compared to parking lot runoff. In order to protect water quality and possibly improve it, stormwater will be discharged to the storm drain system after passing through an oil/water separator.

Because the proposed garage does not include sanitary facilities, cooling or other water-dependent uses, there is no expected increase in sewage as a result of the proposed Harvard Club Garage. Impacts from the garage on energy systems are also anticipated to be minimal. Electricity use is expected to be limited to lighting in the booth area and in the garage. Energy requirements for the manned booth are expected to be limited to a light, telephone, and probably a space heater, which is not unlike the existing booth on-site.

HARVARD CLVB OF BOSTON

II. General Information

II. GENERAL INFORMATION

1.0 APPLICANT INFORMATION

1.1 Project Identification

Project Name:	Harvard Club Garage
Address/Location:	Newbury Street between Massachusetts Avenue and Charlesgate East, adjacent to the Massachusetts Turnpike

1.2 Development Team

Developer:	The Harvard Club of Boston, a Massachusetts Corporation 374 Commonwealth Avenue Boston, MA 02215 (617)536-1260 Paul Corcoran
Attorneys:	Peabody & Brown 101 Federal Street Boston, MA 02110-1832 (617) 345-1000 Lawrence DiCara Cynthia Warren
Architect:	Meyer & Meyer 388A Commonwealth Avenue Boston, MA 02215 (617) 266-0555 John Meyer
Construction Manager:	John Moriarty & Associates 8 Winchester Place Winchester, MA 01890 (617) 729-3900 John Moriarty Ralph Vitti

Environmental/ Traffic:	HMM Associates, Inc. 196 Baker Avenue Concord, MA 01742 (508)371-4000 Cindy Schlessinger Michael Przybyla

1.3 Currently or Formerly-Owned Developments in Boston

The existing Harvard Club, located at 374 Commonwealth Avenue, is the only development owned by the Harvard Club of Boston.

2.0 LEGAL INFORMATION

2.1 Legal Actions Pending Concerning the Proposed Project

There are no legal judgments or actions pending involving the project site.

2.2 History of Tax Arrears on Property Owned in Boston

The only property in Boston owned by the Harvard Club of Boston is the Harvard Club on Commonwealth Avenue and the existing parking lot. No taxes are outstanding which are due and owing on the site.

2.3 Evidence of Site Control Over the Project Area

The proposed project is currently owned by the Harvard Club of Boston and there is no known restrictive covenants or contractual restrictions affecting the ability to accomplish the proposed project. Following are descriptions of the easements and restrictions tied to the project.

1) Two 16-foot wide passageways (Appendix B), a portion of which is owned by the Harvard Club of Boston where the Harvard Club property abuts on both sides of the passageway, with perpetual easements to City of Boston for use of passageways to adjoining lots, and drainage and right of way; and

2) Grading easement to City of Boston.

2.4 Public Access Into, Through, or Surrounding the Site

Currently, the proposed project is bounded by Newbury Street and alleys owned by the Harvard Club of Boston and abutters. The Harvard Club and abutters each own to the center line of the alley. The easements to these alleys are as described above and will not change as a result of the project.

3.0 FINANCIAL INFORMATION

3.1 Financially Involved Participants

The Harvard Club of Boston is the only financially involved participant.

3.2 Development and Operating Proformas

The development and operating proformas have been submitted to the BRA under separate cover.

4.0 PROJECT AREA

A description by metes and bounds of each of the parcels constituting the project area is included as Appendix C.

5.0 PUBLIC BENEFITS

The proposed Harvard Club Garage project will have a positive impact on the area in many ways. From an urban design perspective, the existing site is a gap in the urban landscape and the proposed garage will complete the street wall on Newbury Street and will help define and organize the open space created by the Massachusetts Turnpike.

In addition to filling a need for parking by Harvard Club members, the Garage will also provide parking to residents and visitors of an area which has one of the most severe parking shortages in the City. Spaces will be made available to area residents on a monthly basis and will be provided at below market rates. Unlimited access to the garage will be given to neighborhood residents with reserved spaces.

In addition to the benefits described above, the project will also result in traffic and parking benefits. Because of the shortage of parking spaces at the existing lot and the length of time it takes to get into the lot as a result of the valet parking, queuing often extends onto Newbury Street and sometimes beyond. With the additional spaces filling the needs of the Club, and the location of the entry, queuing will take place on-site or will be limited to Newbury Street. With the proposed mitigation, the queue will be accommodated on site. The shortage of spaces at the club forces cars unable to park to circle the area in search of a parking space. The increased number of spaces will also reduce circling caused by the lack of available spaces.

The Harvard Club is currently considering numerous methods to encourage Club members and visitors to take the "T" or other modes of public transportation to the Club and Club functions. Possible options include the inclusion of a column in the monthly newsletter to inform members about public transportation options; the placement and distribution of notices regarding specific functions which include reminders of public transportation options and encourage people to car-pool; and the formation of a transportation committee. Purposes of the committee include determining appropriate ways to encourage members to use public transportation and to work with the community to ensure that the parking needs of the area residents, commercial interests, and Club members are being met by the Garage.

As described previously, the club will continue to meet with abutters and other interested parties to ensure that the benefits of the garage will be shared by the club and the abutters.

6.0 EMPLOYMENT

6.1 Construction Jobs

During construction of the Harvard Club Garage, it is estimated that approximately 24 jobs will be generated at the construction site.

7.0 REAL ESTATE TAXES

The Harvard Club paid approximately $17,000 in taxes on the existing parking lot during the previous year. Following completion of construction, the annual real property taxes for the Harvard Club Garage are projected to be approximately $102,000, resulting in an increase of almost $85,000 to the city annually.

8.0 REGULATORY CONTROLS AND PERMITS

8.1 Existing Zoning Requirements and Anticipated Requests for Zoning Relief

The proposed project is located in the Priority Preservation Subdistrict B of the Downtown Interim Planning Overlay District (IPOD). The Harvard Club will seek an IPOD permit, conditional use permits, and zoning variances from the Board of Appeal.

Conditional use permits for the parking as accessory parking and non-accessory parking will be sought as well as variances for FAR, Rear Yard, Front Yard, and parapet setback.

8.2 Anticipated Permits

Anticipated Permit	Proposed Application/ Submission Date
A. Federal	
None	
B. State	
None	
C. Local	
1) Boston Redevelopment Authority	
- Boston Zoning Code Article 31 Review	
a) Draft PIR	1st quarter/1991
b) Final PIR	2nd quarter/1991
- Recommendation to Board of Appeal	2nd quarter/1991

Anticipated Permit	Proposed Application/ Submission Date
2) Inspectional Services Department - Building Permit	2nd quarter/1991
3) Back Bay Architectural Commission - Project Design Approval	2nd quarter/1991
4) Boston Civic Design Commission - Design Approval	2nd quarter/1991
5) City of Boston Board of Appeal - Conditional Use Permits, Variances, and IPOD Permit	2nd quarter/1991
6) Fire Department - Parking Garage Permit - Fuel Storage Permit	2nd quarter/1991

9.0 COMMUNITY GROUPS

9.1 Interested Parties

Following is a list of parties which may be substantially interested or affected by the project.

- Colonial Condominium Trust - 382 Commonwealth Avenue
- Ronald F. Cahaly, Trustee - Rental Building @ 384 Commonwealth Avenue
- Fifty 7 West Cedar Condominium Trust - 386 Commonwealth Avenue
- Windsor Place Condominium Trust - 388-390 Commonwealth Avenue
- Boston Redevelopment Authority
- Mayor's Office of Neighborhood Services
- Neighborhood Association of the Back Bay
- Back Bay Architectural Commission
- Back Bay Association
- Boston Society of Architects
- Greater Boston Real Estate Board
- Newbury St. League
- Kenmore Square Business Association

9.2 Meeting Log

The most recent community meeting was held in early December, 1990 and the initial meeting was held over one year ago. The Harvard Club plans to continue to meet with community groups and other interested parties to allow a development satisfactory to all parties.

10.0 PROJECT SCHEDULE

Construction of the proposed Harvard Club Garage is expected to last for eight months from June 1991 through January 1992.

III. Transportation Component

III. TRANSPORTATION COMPONENT

1.0 INTRODUCTION

1.1 Description of the Club

Located at 374 Commonwealth Avenue, the Harvard Club of Boston provides a wide variety of services to its members. Facilities include a restaurant and grill/bar, men's and women's fitness centers, function rooms, and accommodations for overnight guests. The Club sponsors a variety of social and educational activities such as luncheons, dinners, lectures, travelogues, and other similar events. The majority of members are from the Greater Boston area, though guests from out of town are also served.

1.2 Project Description

The Harvard Club presently operates a surface parking lot with a licensed capacity of 105 spaces. The lot is open to Harvard Club patrons and employees only, with an on-site attendant and booth near the entry point. This facility is located behind the Harvard Club's building with vehicular access provided by a driveway off of Newbury Street. The number of spaces in this lot does not meet the current demands of the Club based on the number of cars turned away during club events. This lack of adequate parking causes Club patrons to be turned away, forcing them to circle the neighborhood, seeking alternate parking in other facilities.

To alleviate this situation, the Harvard Club is proposing to construct a 430 space parking garage on the site of the existing surface lot. This lot will have enough capacity to accomodate peak Club demands, as well as provide parking for non-Club patrons such as Back Bay residents, visitors of the Eliot Hotel, and other commercial establishments to the extent possible during off-peak periods. As described earlier, it is currently proposed that 100 spaces will be reserved for Back Bay residents, between 140 to 300 spaces will be used for the Club, and 30 to 190 spaces will be used as short-term commercial spaces.

1.3 Traffic Study Area

The study area for the proposed project is bounded by Massachusetts Avenue, Newbury Street, Charlesgate East, and Commonwealth Avenue. As requested by the

Scoping Determination issued by the Boston Redevelopment Authority (BRA), the following five intersections were examined:

- Massachusetts Avenue at Newbury Street;
- Charlesgate East at Commonwealth Avenue Eastbound;
- Charlesgate East at Commonwealth Avenue Westbound;
- Massachusetts Avenue at Commonwealth Avenue Eastbound, and;
- Massachusetts Avenue at Commonwealth Avenue Westbound.

AM and PM traffic counts were conducted at these intersections and level of service (LOS) analyses were performed for the following conditions:

- 1990 Existing Conditions;
- 1994 No-Build Conditions, with area background development included, and;
- 1994 Build Conditions (within the Build condition analysis, two options for surplus parking space allocation were studied).

2.0 EXISTING CONDITIONS

2.1 Access and Circulation

Access to the proposed project will be from Newbury Street. Newbury Street is one way westbound at the site thereby allowing only right turns in/out from the existing surface lot and future garage. Newbury Street intersects with Charlesgate East several hundred feet west of the site. Charlesgate East is one way northbound. Commonwealth Avenue provides the major east/west access to the site. This street has a wide landscaped median and effectively operates as two streets, one eastbound and one westbound. Massachusetts Avenue is the major north/south facility in the study area and provides two lanes in each direction. At the intersection of Newbury Street/Massachusetts Avenue, access to the westbound lanes of the Massachusetts Turnpike is provided. Figure III-1 illustrates the general circulation pattern in the study area.

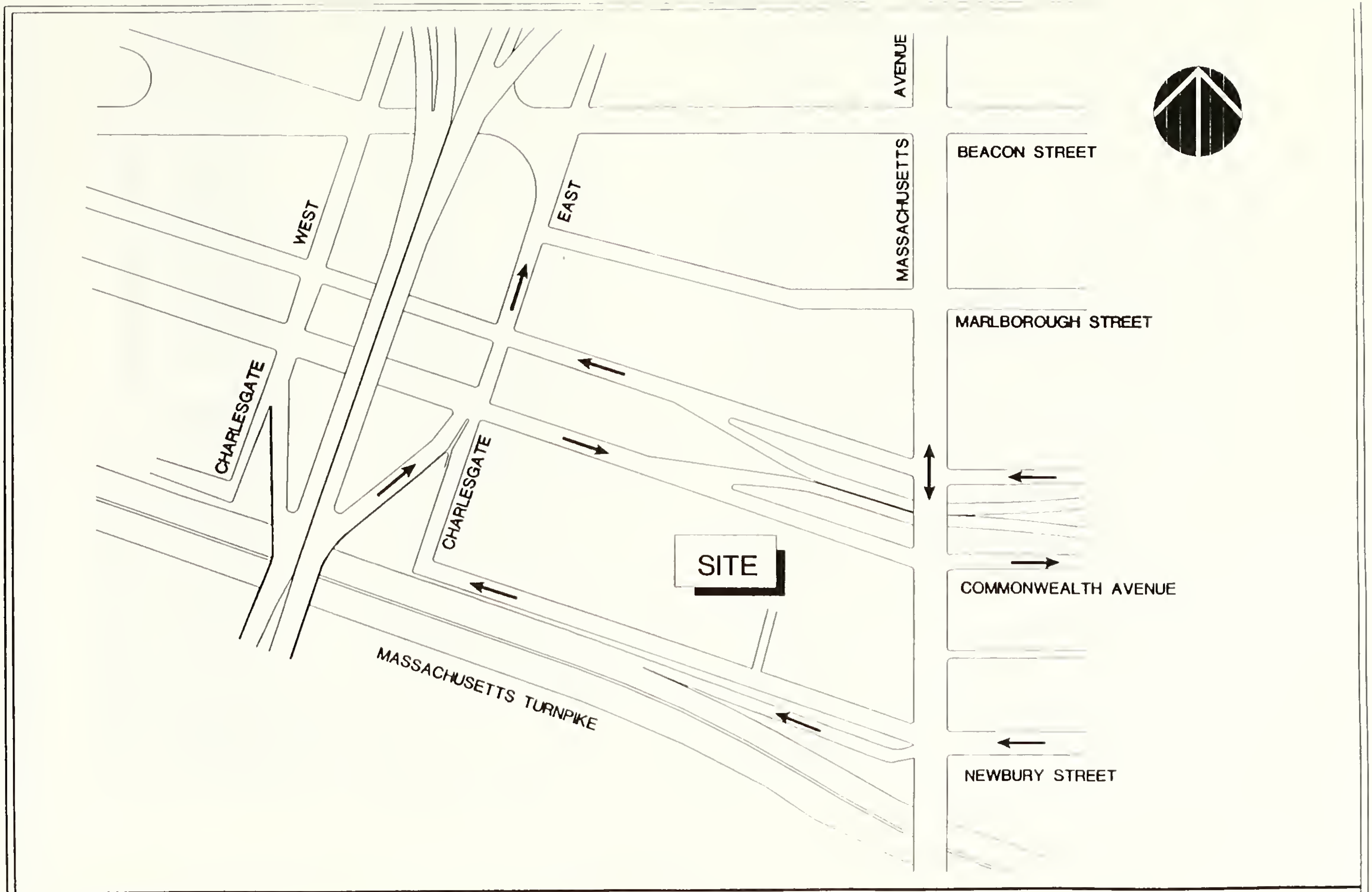

Figure III-1
Study Area Circulation

2.2 Traffic Volumes

Manual traffic turning movement counts were taken from 7:00 AM to 9:00 AM and 4:00 PM to 6:00 PM*. These times cover the AM and PM peak weekday commuting periods. Due to construction on the Harvard Bridge over the Charles River, the PM peak hour count for the intersection of Massachusetts Avenue and Commonwealth Avenue did not reflect normal conditions. In order to account for the unusual conditions, the numbers were adjusted using earlier Boston Transportation Department (BTD) counts. The traffic volume worksheets are presented in Appendix D.

These peak hour counts were adjusted to reflect peak month conditions, thereby representing a worst case condition. Figures III-2 and III-3 show the AM (8:00-9:00) and PM (5:00-6:00) peak hour traffic volumes, respectively.

Saturday peak hour volumes were estimated using the Saturday peak hour (2:00-3:00 PM) traffic counts in the Prudential Center Redevelopment Project Impact Report/Environmental Impact Report (PIR/EIR). From this data, it was determined that the Saturday peak hour volumes for the composite study area are approximately 85% of the weekday PM peak hour volumes. Figure III-4 shows the estimated Saturday peak hour traffic volumes.

2.3 Existing Traffic Operating Conditions

Traffic operations were analyzed according to standard procedures and practices outlined in the 1985 Highway Capacity Manual.** The efficiency of traffic operations at a location is measured in terms of "Level of Service" (LOS). The LOS refers to the quality of traffic flow along roadways and at intersections. It is described in terms of Levels A through F, where A represents the best possible conditions and F represents forced-flow or failing conditions. Level of Service D or better is considered an acceptable operating condition in urban areas.

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* All traffic counts except Charlesgate East/Commonwealth Avenue westbound were obtained from Howard/Stein-Hudson Associates and were counted between late November and early December 1989. The Charlesgate East/Commonwealth Avenue WB intersection was counted by HMM Associates in May 1990.

** Transportation Research Board, Highway Capacity Manual, Special Report 209; National Research Council, 1985.

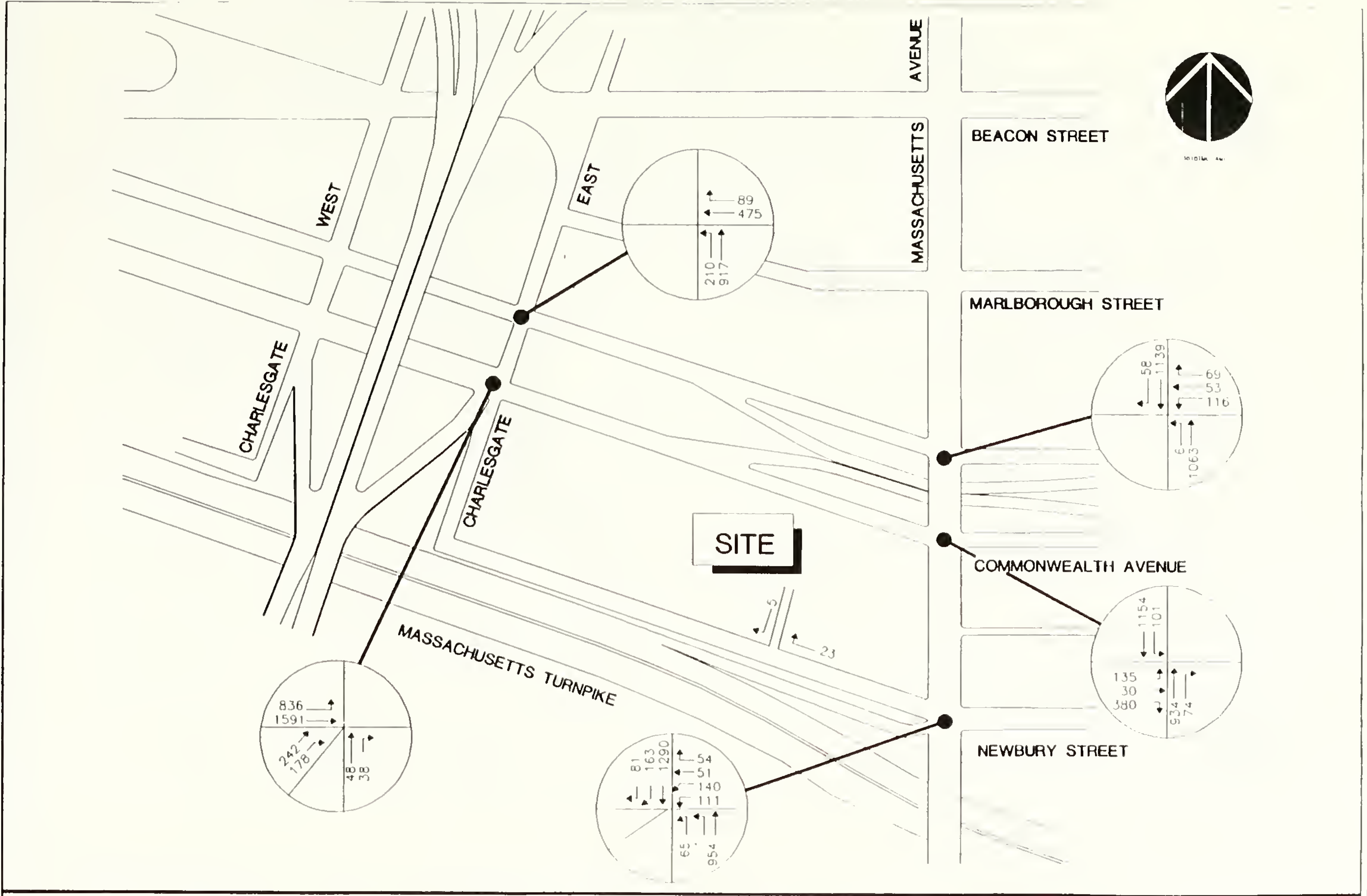

Figure III-2
Existing AM Peak Hour Traffic Volumes

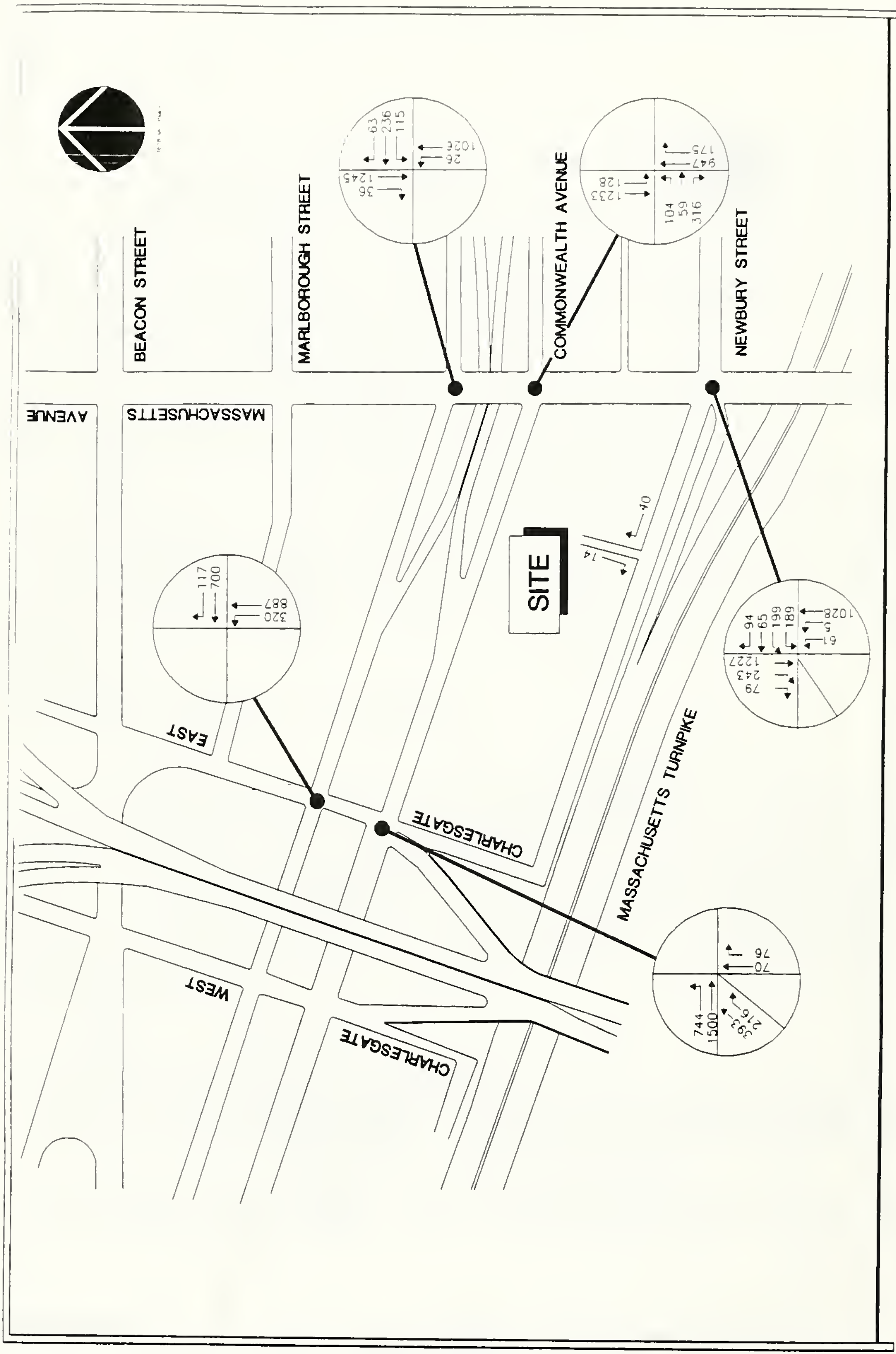
BEACON STREET
MARLBOROUGH STREET
COMMONWEALTH AVENUE
NEWBURY STREET
MASSACHUSETTS AVENUE
EAST
CHARLESGATE
WEST
CHARLESGATE
MASSACHUSETTS TURNPIKE
SITE
40
14
63
236
115
1026
26
1245
36
175
947
128
1233
104
59
316
117
700
887
320
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Figure III-3

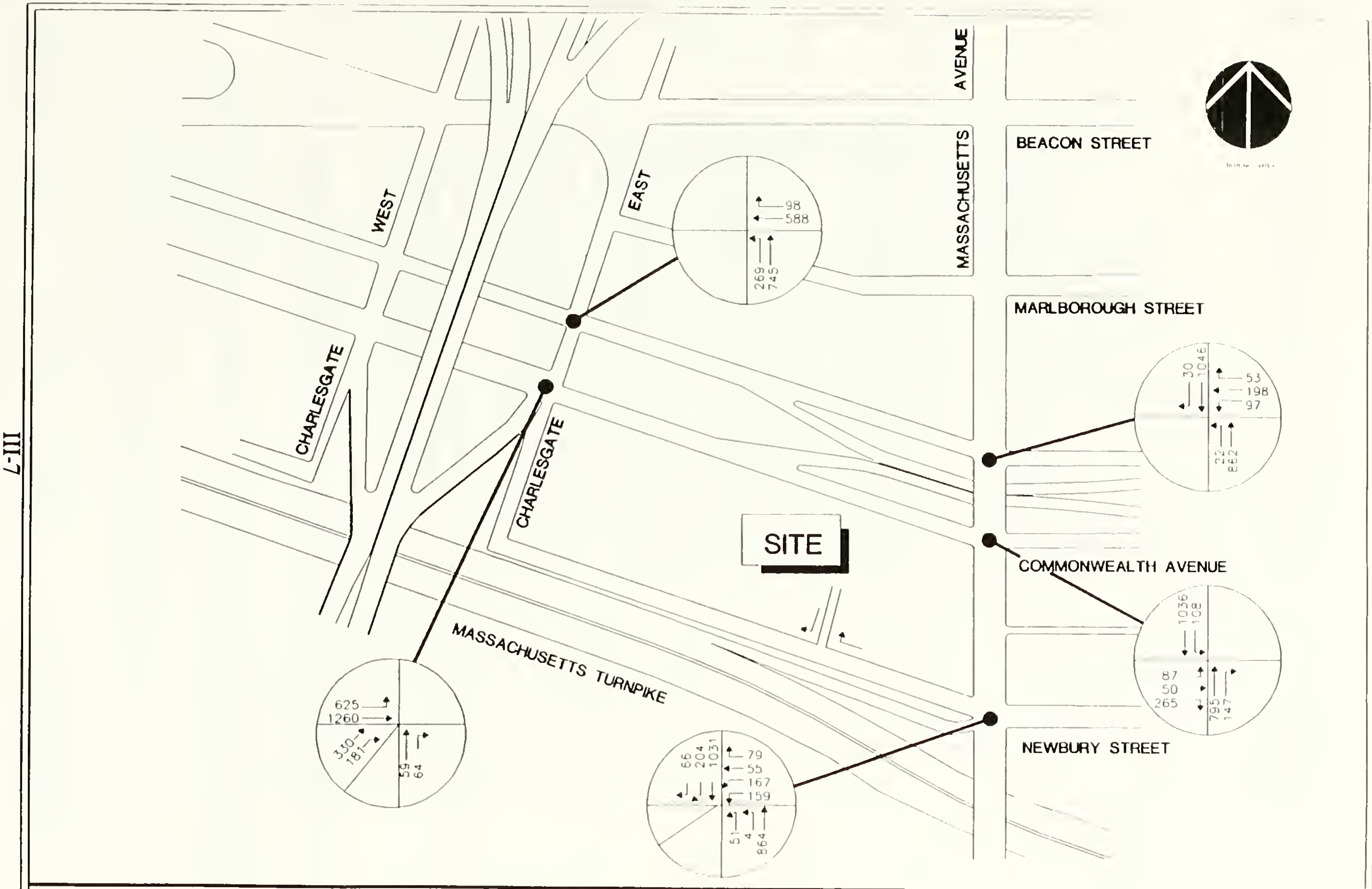

Figure III-4
Exisiting Saturday Peak Hour Traffic Volumes

At signalized intersections, LOS is defined in terms of "average approach delay." For unsignalized intersections representative of those in the study area, "reserve capacity" is used to determine LOS. These measures are discussed briefly below and Table III-1 summarizes their relationships.

Average delay is a measurement of the mean stopped delay experienced by vehicles entering a signalized intersection during the peak hour period. Average delay is measured for each individual approach and the intersection as a whole. The LOS deteriorates with increasing average delays. Reserve capacity is the unused capacity of an approach lane(s) to an unsignalized intersection. This measure, defined in passenger cars per hour, indicates how many more vehicles using an individual approach would be required to bring the intersection leg to capacity.

Intersection capacity analyses were performed to identify weekday commuter peak hour (AM and PM) LOS at study area intersections for existing traffic conditions as well as future conditions with and without the proposed development. Detailed LOS calculations for each of these analyses cases are presented in Appendix E.

Table III-2 shows the existing levels of service at the five study area intersections for the AM, PM, and Saturday peak hours. As can be seen, all but two of the intersections operates at LOS E or worse during at least one of the peak hours. The worst intersection is the Charlesgate East/Commonwealth Avenue eastbound intersection which operates at LOS F during both the AM and PM peak hours. The intersection of Massachusetts Avenue/Commonwealth Avenue eastbound operates at acceptable levels of service in all but the PM peak hour, when it drops to LOS F. The intersection of Massachusetts Avenue/Newbury Street operates at LOS C during both the AM and Saturday peak hours, and at LOS E during the PM peak hour. Although illegal, a substantial number of left turns from Massachusetts Avenue northbound onto Newbury Street and the Massachusetts Turnpike on-ramp occur at this intersection and these movements were included in the analysis. Field observations indicate that there is no turn prohibition sign at this intersection, though the signal indication for northbound traffic is a vertical green arrow indicating that this is the only permitted movement. The intersection of Massachusetts Avenue/Commonwealth Avenue westbound operates at acceptable levels of service during all three periods.

TABLE III-1

INTERSECTION LEVEL OF SERVICE (LOS) DESIGNATIONS*

Category	Description	Delay Range (Seconds per vehicle**	Reserve Capacity (Passenger Cars Per Hour)***
LOS A:	Describes a condition of free flow, with low volumes and relatively high speeds. There is little or no reduction in maneuverability due to the presence of other vehicles, and drivers can maintain their desired speeds. Little or no delays result for side street motorists.	0.00 - 05.0	≥ 400
LOS B:	Describes a condition of stable flow, with desired operating speeds relatively unaffected, but with a slight deterioration of maneuverability within the traffic stream. Side street motorists experience short delays.	5.1 - 15.0	300 - 399
LOS C:	Describes a condition still representing stable flow, but speeds and maneuverability begin to be restricted. The general level of comfort begins to deteriorate noticeably at this level. Motorists entering from side streets experience average delays.	15.1 - 25.0	200 - 299
LOS D:	Describes a high-density traffic condition approaching unstable flow. Speeds and maneuverability become more seriously restricted, and the driver experiences a poor level of comfort. Side street motorists may experience long delays.	25.1 - 40.0	100 - 199
LOS E:	Represents conditions at or near the capacity of the facility. Flow is usually unstable, and freedom to maneuver within the traffic stream becomes extremely difficult. Very long delays may result for side street motorists.	40.1 - 60.0	0 - 99
LOS F:	Describes forced flow or breakdown conditions with queuing along critical approaches. Operating conditions are highly unstable as characterized by erratic vehicle movements along each approach.	60.1 or greater	N/A

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[*] Source: Highway Capacity Manual, Transportation Research Board Special Report 209; National Research Council, 1985.

[**] Delay ranges relate to the mean stopped delay incurred by all vehicles entering the intersection and do not consider the effects of traffic signal coordination. This criteria is intended for use in the evaluation of signalized intersections.

[***] Reserve capacity refers to the unused capacity of an intersection approach, on a per lane basis. This criteria is limited to use in the evaluation of unsignalized intersections.

Intersection	Peak Hour	Existing	
		LOS	Avg. Delay (Sec./Veh.)
#1: Charlesgate East/ Comm. Ave. WB	AM	C	15.3
	PM	C	17.7
	SAT	B	12.8
#2: Charlesgate East/ Comm. Ave. EB	AM	F	130.8
	PM	F	149.0
	SAT	D	39.6
#3: Mass. Ave./ Newbury St.	AM	C	18.4
	PM	E	48.7
	SAT	C	17.9
#4: Mass. Ave/ Comm. Ave. EB	AM	D	36.5
	PM	F	90.2
	SAT	B	11.5
#5: Mass. Ave/ Comm. Ave. WB	AM	B	6.9
	PM	D	37.7
	SAT	B	9.4

Table III-2

Existing Traffic Operations Summary

2.4 Existing Harvard Club Parking Lot Operation

In order to assess the use of the existing Harvard Club lot, a survey of parkers was conducted on three days in November 1988 from 7:00 AM to Midnight*. The survey involved the recording of license plates, number of arrivals and departures, and a brief user-return survey card. Table III-3 shows a summary of the parking data collected.

On average, 277 parkers were accomodated in a single day. Peak occupancy ranged from 111 spaces to 137 spaces. Both of these figures are well in excess of the licensed capacity of 105 cars. The number of vehicles turned away during these times was not recorded. The average parking duration was 3.5 hours.

Vehicle occupancy was 1.35 persons per vehicle, with almost three-quarters (72%) of the parkers arriving in single occupant vehicles.

The majority of parkers were Harvard Club members (77%), with 13% guests or function attendees, and 9% employees. Slightly more than 40% of the parkers originated in the Downtown Boston, Boston, or Cambridge area, with the remaining 60% evenly split between areas inside and outside of Route 128.

Figure III-5 shows the distribution of parking during the day. As can be seen the peak arrival period for the lot is outside of both the AM and PM peak commuter hours. Generally, the peak arrival period occurs slightly later than the PM commuter peak hour.

3.0 BACKGROUND DEVELOPMENT - 1994 NO-BUILD CONDITIONS

3.1 Other Study Area Projects

In order to incorporate new vehicle trips generated by surrounding planned and proposed developments, the 1994 Build traffic volumes (AM, PM, and Saturday peak hours) from the Prudential DPIR/DEIR were used. The only study area intersection common to both this report and the Prudential DPIR/DEIR is the intersection of Massachusetts Avenue/Newbury Street. The difference between the Existing Prudential peak hour traffic volumes and the 1994 Build Prudential volumes was used to determine the overall number of new trips in the study area attributable to other developments. In addition, trips associated with the Olmsted Plaza project as outlined in the Olmsted Plaza FPIR/FEIR were also included.

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* Survey conducted by Howard/Stein-Hudson Associates.

Parking Survey Summary

Day	Total Parkers (Cars)	Average Duration	Peak Occupancy (Spaces)	Time of Peak	Special Event
Tue. 11/15/88	271	3:20	111	6:30 PM	Travelog (PM)
Wed. 11/16/88	291	3:20	128	12:30 PM	Kalb Lunch/Celtics (PM)
Fri. 11/18/88	270	3:35	137	7:15 PM	None
Average:	277	3:25	125	N/A	

Classification of Parkers (Average Day)

Type of Parker	Percent of Total
Club Member	77%
Guest	8%
Function Attendee	5%
Employee	9%
Other	1%
TOTAL	100%

Origins of Parkers

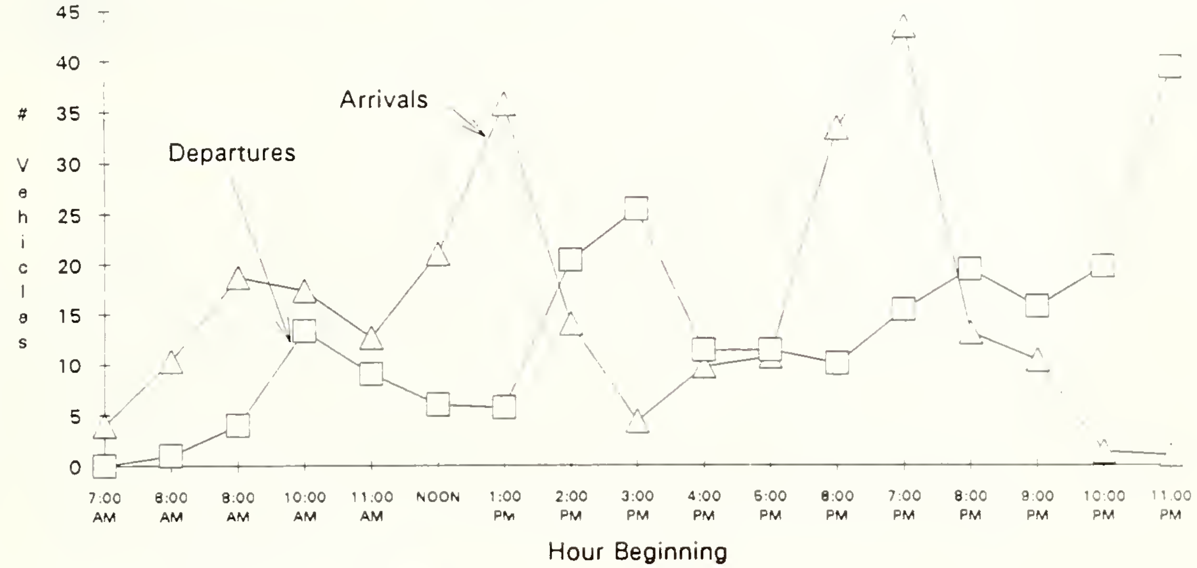
Origin Area	Percent of Total
Downtown Boston	14%
Other Boston	16%
Cambridge	11%
Other Inside Rte. 128	29%
Other Outside Rte. 1	29%
TOTAL:	99%

Source: Howard/Stein-Hudson Associates

Table III-3

Existing Parking Characteristics

Arrivals & Departures
Existing Harvard Club Lot
Average of 3 Events, November 1988



Source: Howard/Stein-Hudson Associates

Spaces Occupied by Time of Day
Average of 3 Events, November 1988

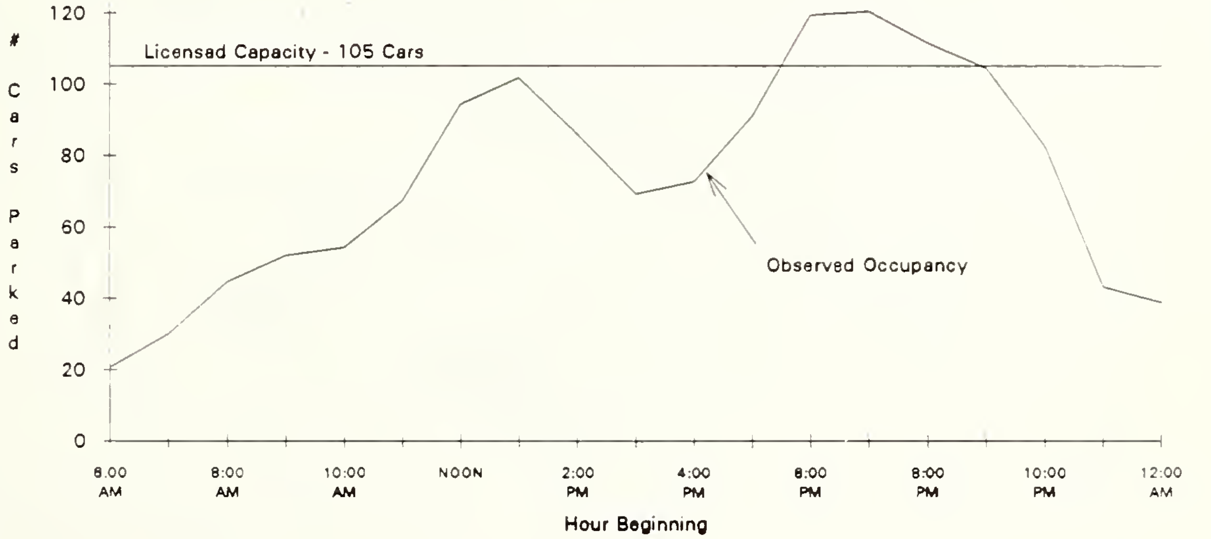


Figure III-5
Parking Distribution

To account for the general non-project specific growth in traffic, an annual growth factor of 0.5 percent per year was used. This is the same figure used in the Prudential DPIR/DEIR.

The resultant new trips were added to the existing peak hour volumes. Figures III-6 through III-8 show the 1994 No-Build traffic volume for the AM, PM, and Saturday peak hours.

3.2 Proposed Roadway Improvements

According to the Boston Transportation Department (BTD), the only roadway improvement under consideration in the study area is a proposal to improve Massachusetts Avenue to allow three lanes of traffic in each direction. As part of this plan, consideration will be given to making the left turn from Massachusetts Avenue northbound onto Newbury Street and the Massachusetts Turnpike on-ramp legal. These proposed improvements have been included in the analysis for both the No-Build and Build conditions.

3.3 1994 No-Build Traffic Operations

Using the 1994 No-Build peak hour volumes, the level of service for each intersection was calculated as shown in Table III-4. As can be seen, future traffic operations in the study area deteriorate slightly from existing conditions. However, level of service along Massachusetts Avenue improves dramatically due to the proposed BTD improvements on Massachusetts Avenue.

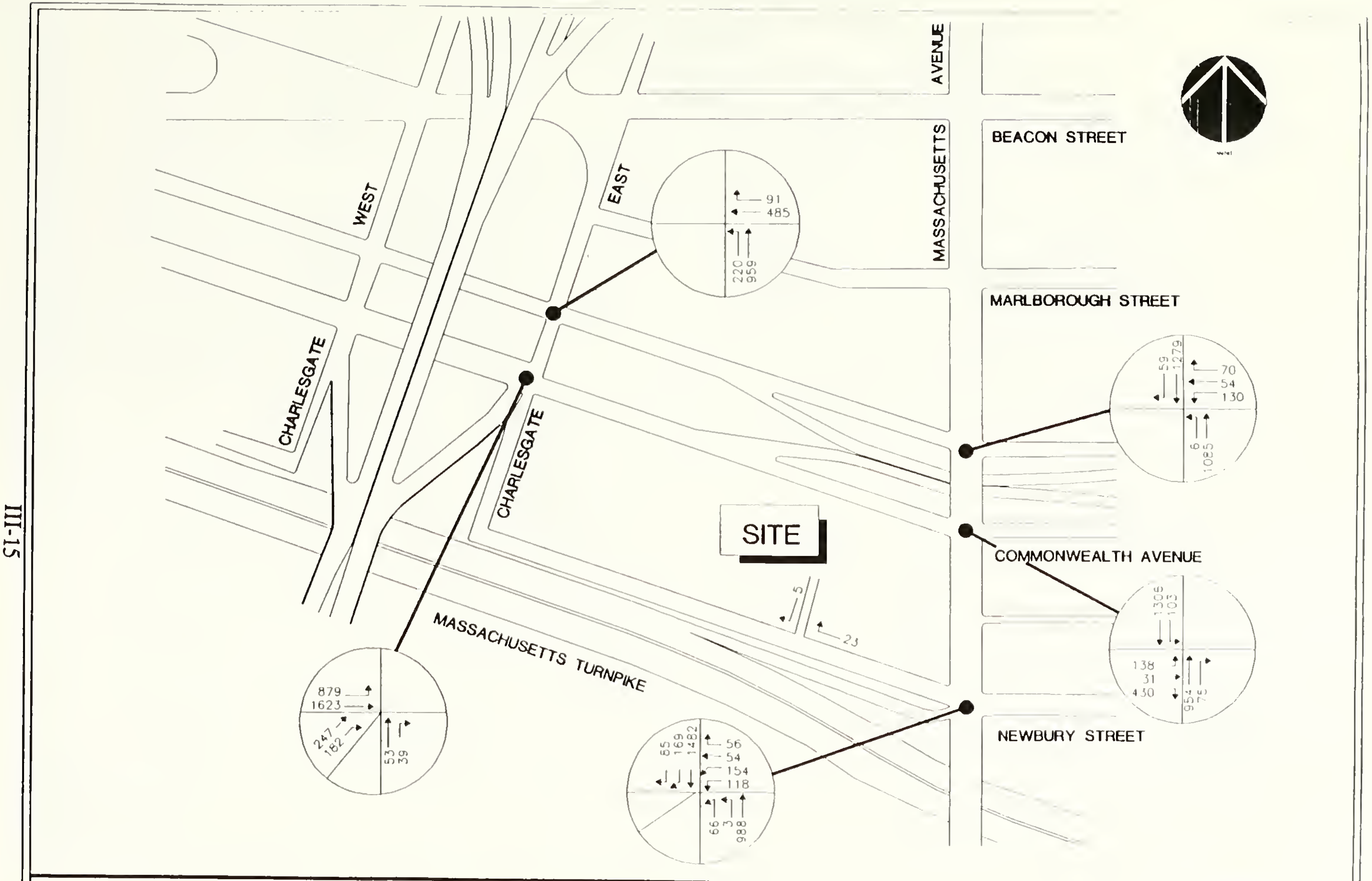
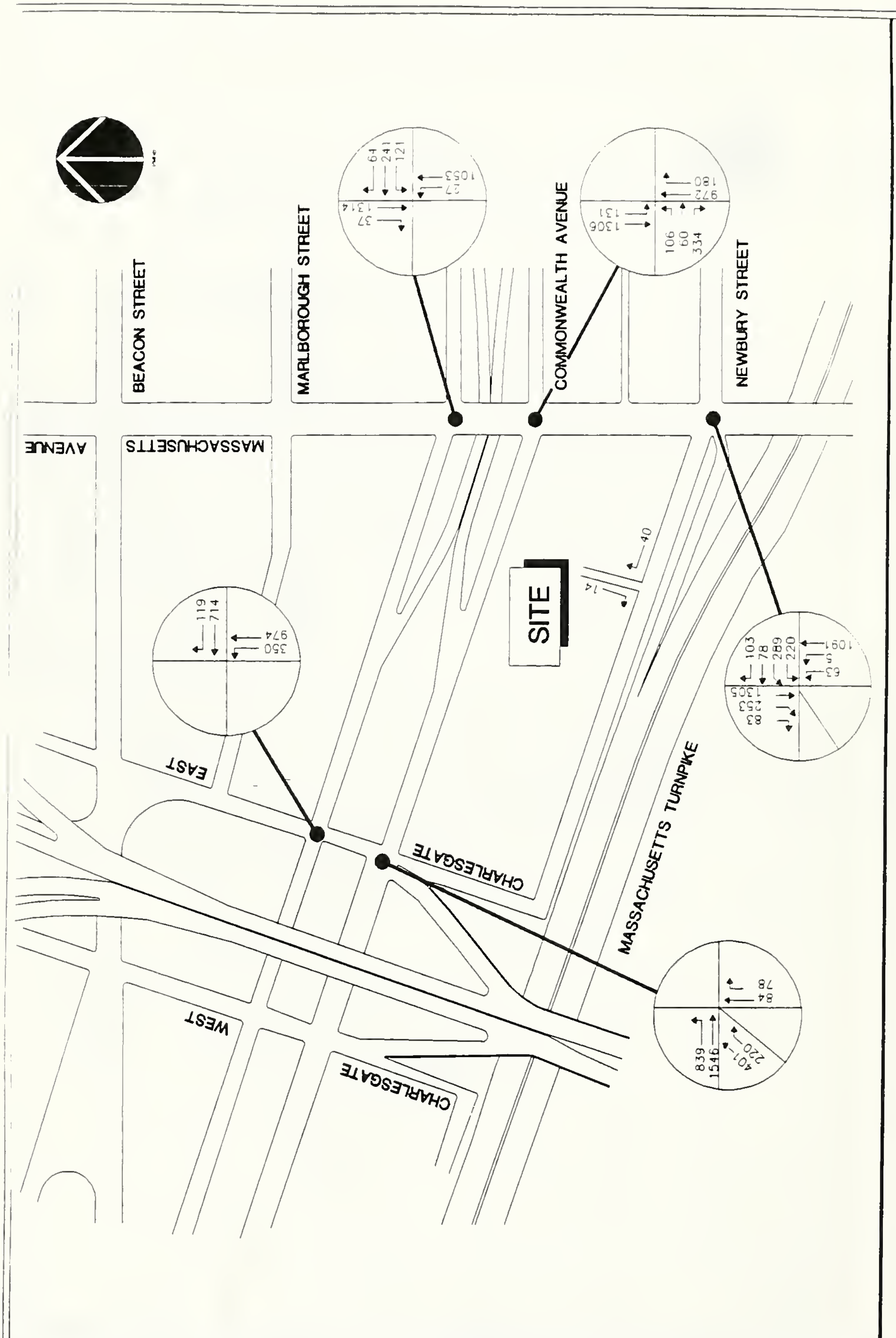


Figure III-6

1994 No-Build AM Peak Hour Traffic Volumes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MARLBOROUGH STREET
COMMONWEALTH AVENUE
NEWBURY STREET
MASSACHUSETTS AVENUE
EAST
CHARLESGATE
WEST
CHARLESGATE
MASSACHUSETTS TURNPIKE
SITE
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64
241
121
1053
27
1314
37
180
972
131
1306
106
60
334
119
714
974
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Figure III-7

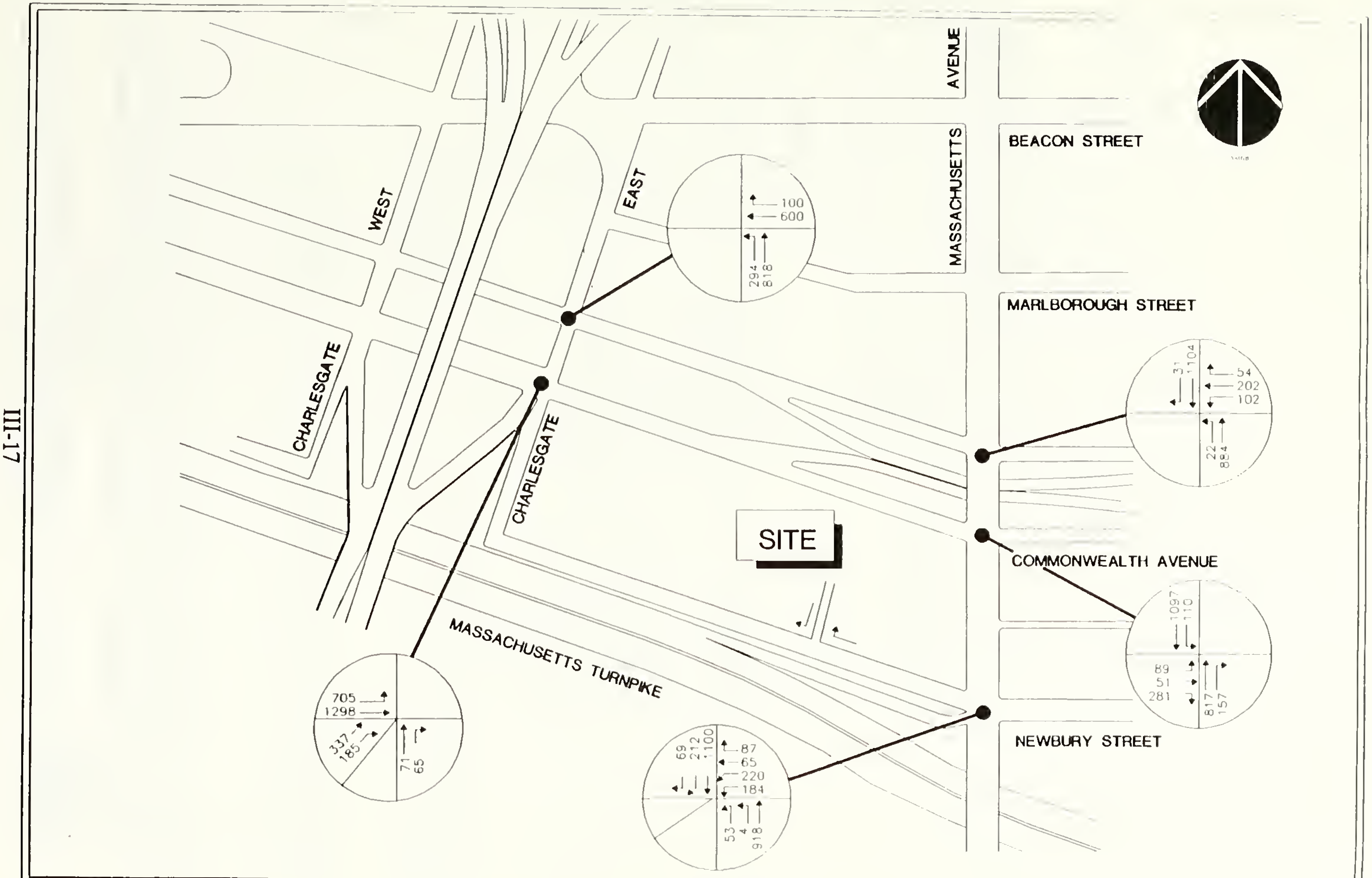

Figure III-8
1994 No-Build Saturday Peak Hour Traffic Volumes

Intersection	Peak Hour	Existing LOS	Existing Avg. Delay (Sec./Veh.)	1994 No Build LOS	1994 No Build Avg. Delay (Sec./Veh.)
#1: Charlesgate East/ Comm. Ave. WB	AM	C	15.3	C	18.2
	PM	C	17.7	C	18.6
	SAT	B	12.8	B	13.5
#2: Charlesgate East/ Comm. Ave. EB	AM	F	130.8	F	143.7
	PM	F	149.0	F	174.9
	SAT	D	39.6	E	46.7
#3: Mass. Ave./ Newbury St.	AM	C	18.4	B	10.8
	PM	E	48.7	D	31.4
	SAT	C	17.9	C	16.3
#4: Mass. Ave/ Comm. Ave. EB	AM	D	36.5	B	11.0
	PM	F	90.2	B	9.2
	SAT	B	11.5	B	6.8
#5: Mass. Ave/ Comm. Ave. WB	AM	B	6.9	A	4.8
	PM	D	37.7	B	9.2
	SAT	B	9.4	B	7.2

Table III-4

1994 No-Build Traffic Operations

4.0 PROJECT IMPACTS

4.1 Proposed Use

The proposed 430-space garage is intended to allow the Harvard Club to meet its parking needs on-site, without having to turn away member and guest vehicles thereby forcing them to circle the area and use the limited off-site parking facilities. The project does not entail any expansion of the Club's facilities.

The capacity of the club is estimated to be approximately 400 persons. This figure can vary slightly depending on the the type of events being held at the Club. Assuming a vehicle occupancy of 1.35 persons per vehicle, approximately 296 spaces would be required to meet the demands of the Club when it is operating at or near capacity. The remaining available spaces could be allocated and managed to help relieve some of the parking constraints in the immediate Back Bay area.

4.2 Project Alternatives

The BRA Scoping Determination outlined the following three scenarios to be examined in assessing the impacts of the proposed Harvard Club Garage.

- Alternative 1 - Garage size meeting IPOD regulations. This alternative would provide parking sufficient to meet the demands of only the Harvard Club. During off-peak club hours, some spaces would be available to Back Bay residents.

- Alternative 2A - This alternative would provide a 430 space garage of which 140 would be reserved for Club patrons, 100 designated as short-term spaces, and 190 as long-term, leased spaces.

- Alternative 2B - This alternative would also provide 430 spaces of which 140 would be reserved for Club patrons, 250 short-term, and 40 long-term, leased spaces.

The actual allocation of spaces will fall somewhere between the two extremes of Alternatives 2A and 2B. It is currently anticipated that 100 spaces will be reserved for Back Bay residents and a minimum of 140 spaces will be reserved for the Club. The remaining spaces will be allocated between commercial uses and the Club, depending on the time of day. During the day when commercial demands are high and Club parking demands are low, a greater portion of the overlap spaces will be used by commercial users. In the evening when the Club demand is greater, a larger portion of the overlap spaces will be used by the Club. The increased number of Club spaces occurs after the PM peak hour and therefore does not impact traffic conditions during the PM peak.

The traffic generation associated with each of these alternatives is discussed in the following section.

4.3 Trip Generation

Unlike other land uses (i.e., offices, retail stores, factories), parking garages do not generate *new* trips. If associated with a new development, such as an office or store, the new trips are generated by that land use. If the garage is not associated with any new developments, as this one is, existing traffic on the street network may be diverted to the new parking facility. In an area such as the Back Bay where parking supply is limited and cars are often turned away at garages, many cars are forced to circle the area in search of a parking space. The addition of new parking spaces may reduce the extent of motorist circling in search of parking spaces. Although the reduction in circling does not reduce the number of trips generated, it may reduce the amount of traffic in the area.

Since the three peak hour analysis periods are not coincident with the peak Club hour, and therefore not the period when the existing parking lot is most constrained by the limited number of spaces, it is assumed that no new Club trips will be generated by the new parking garage during the AM, PM, and Saturday peak hours. Therefore, for Alternative 1 (the alternative consistent with the IPOD), no new trips will be added to the surrounding street network, and traffic operations will be essentially identical to No-Build conditions.

For Alternatives 2A and 2B, it is once again assumed that no new Club trips will be generated during the peak hours analyzed. However, new trips will be generated in the immediate vicinity by the surplus spaces available to non-Club users. The number of trips generated by Alternatives 2A and 2B are based on the number of spaces available. It was assumed that all short-term spaces would be used by shoppers or other non-work related uses and that all long-term spaces would be used by non-residents. This should be considered a worst case condition, because if Back Bay residents were using some of the long-term spaces, less trips would be generated during the commuter peak hours.

The actual number of new trips generated was estimated using data from the Prudential DPIR/DEIR. Tables III-5 and III-6 show the trip rates used and the number of new trips estimated to be generated during each of the three peak periods for Alternatives 2A and 2B. For Alternative 2A a total of 75 new trips would be generated during the AM peak hour, 82 during the PM peak hour, and 36 during the Saturday peak hour. For Alternative 2B, 22 new trips are generated in the AM, 53 in the PM and 90 on Saturday. The differences in peak hour trip generation between the two alternatives results from the differences in the number of spaces designated as short-term versus long-term (monthly leased). Since the short-term spaces are assumed to be used for non-work trips, there is a minimal number of trips generated during the AM peak hour and somewhat fewer trips generated during the PM peak hour. However, Saturday peak hour trips generated by the short-term spaces are significantly higher.

4.4 Trip Distribution and Assignment

New trips were assigned to the study area street network based on the trip distribution used in the Prudential DPIR/DEIR. Figure III-9 shows the trip distribution used. Figures III-10 through III-12 show the assignment of the new trips onto the study area street network for each of the peak hours analysed. As shown, the intersections of Charlesgate East/Commonwealth Avenue Eastbound and Massachusetts Avenue/ Newbury Street receive the most site-generated traffic. This is primarily due to the one-way street pattern in the area. At the intersection of Massachusetts Avenue/Newbury Street, it was assumed that the left turn from Massachusetts Avenue northbound onto Newbury Street would remain illegal. As stated before, however, it is anticipated that the proposed improvements under consideration along Massachusetts Avenue would have a beneficial impact on traffic. Trips originating form the south would access the site from Newbury Street. For each alternative, the new traffic was added to the appropriate 1994 No-Build peak hour volumes. Figures III-13 through III-18 show the resultant 1994 Build peak hour traffic volumes.

4.5 1994 Build Traffic Operations

Using the 1994 Build traffic volumes, level of service was analyzed for each of the study area intersections. Table III-7 shows the results of this analysis. The analysis showed that there would be no changes in LOS at any of the intersections under either Build alternative. The only change would be slight increases in the average delay.

Table III-5

Percent of Daily In and Out Trips During Peak Hours

Use	AM Peak Hour In	AM Peak Hour Out	AM Peak Hour Total	PM Peak Hour In	PM Peak Hour Out	PM Peak Hour Total	Sat. Peak Hour In	Sat. Peak Hour Out	Sat. Peak Hour Total
Monthly Spaces:	34%	4%	38%	1%	34%	35%	0%	0%	0%
Short Term Spaces:	1%	1%	2%	5%	10%	15%	18%	18%	36%

Source: Weekday peak hour rates Table III-29, Prudential DPIR/DEIR, April 1989
Saturday rates page III-107, Prudential DPIR/DEIR, April 1989.

Table III-6

Trip Generation

Alternative 2A	AM Peak Hour In	AM Peak Hour Out	AM Peak Hour Total	PM Peak Hour In	PM Peak Hour Out	PM Peak Hour Total	Sat. Peak Hour In	Sat. Peak Hour Out	Sat. Peak Hour Total
190 Monthly Spaces:	65	8	73	2	65	67	0	0	0
100 Short Term Spaces:	1	1	2	5	10	15	18	18	36
Total:	66	9	75	7	75	82	18	18	36

Alternative 2B	AM Peak Hour In	AM Peak Hour Out	AM Peak Hour Total	PM Peak Hour In	PM Peak Hour Out	PM Peak Hour Total	Sat. Peak Hour In	Sat. Peak Hour Out	Sat. Peak Hour Total
40 Monthly Spaces:	14	2	16	1	14	15	0	0	0
250 Short Term Spaces:	3	3	6	13	25	38	45	45	90
Total:	17	5	22	14	39	53	45	45	90

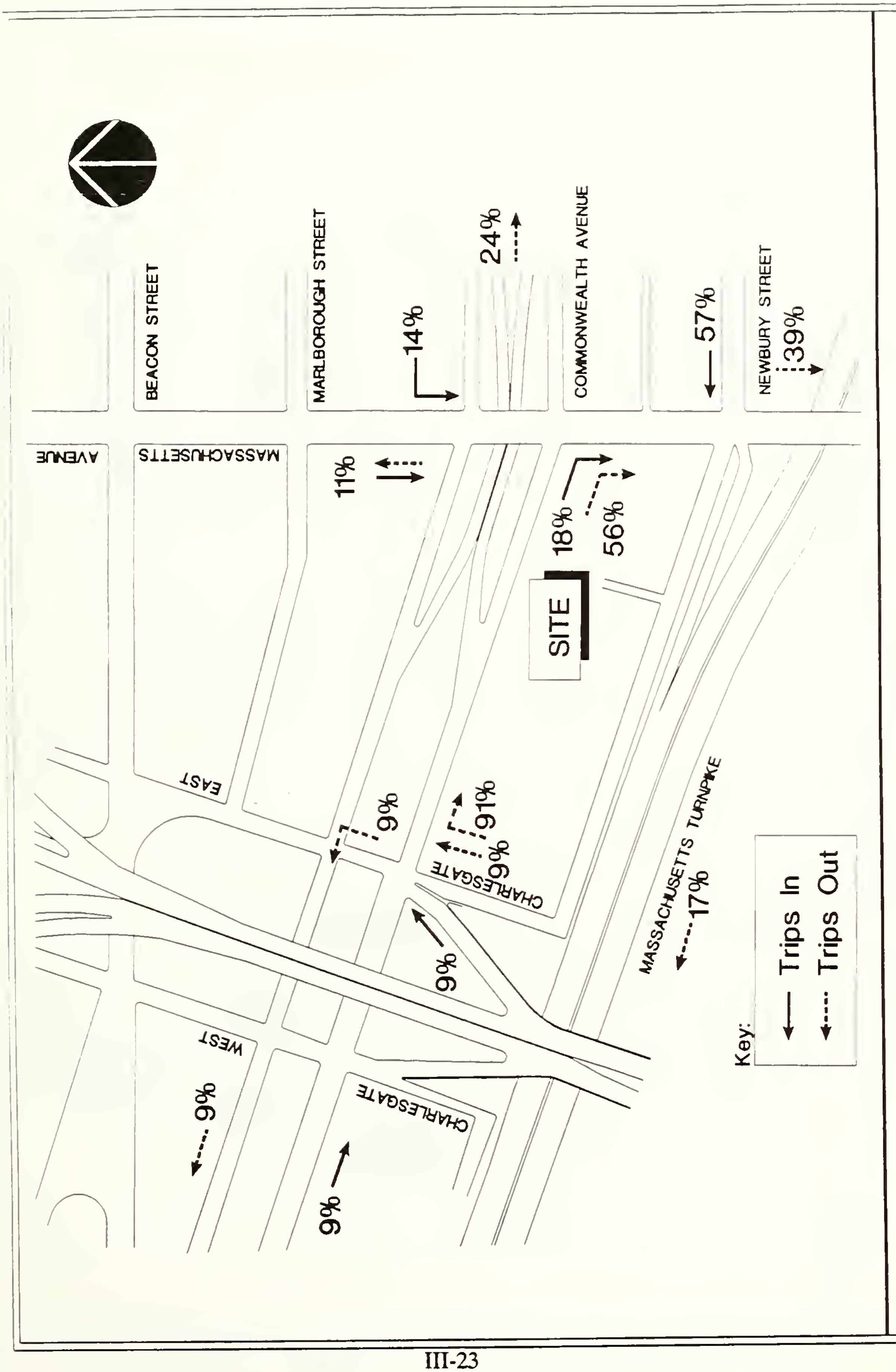

Figure III-9
Trip Distribution

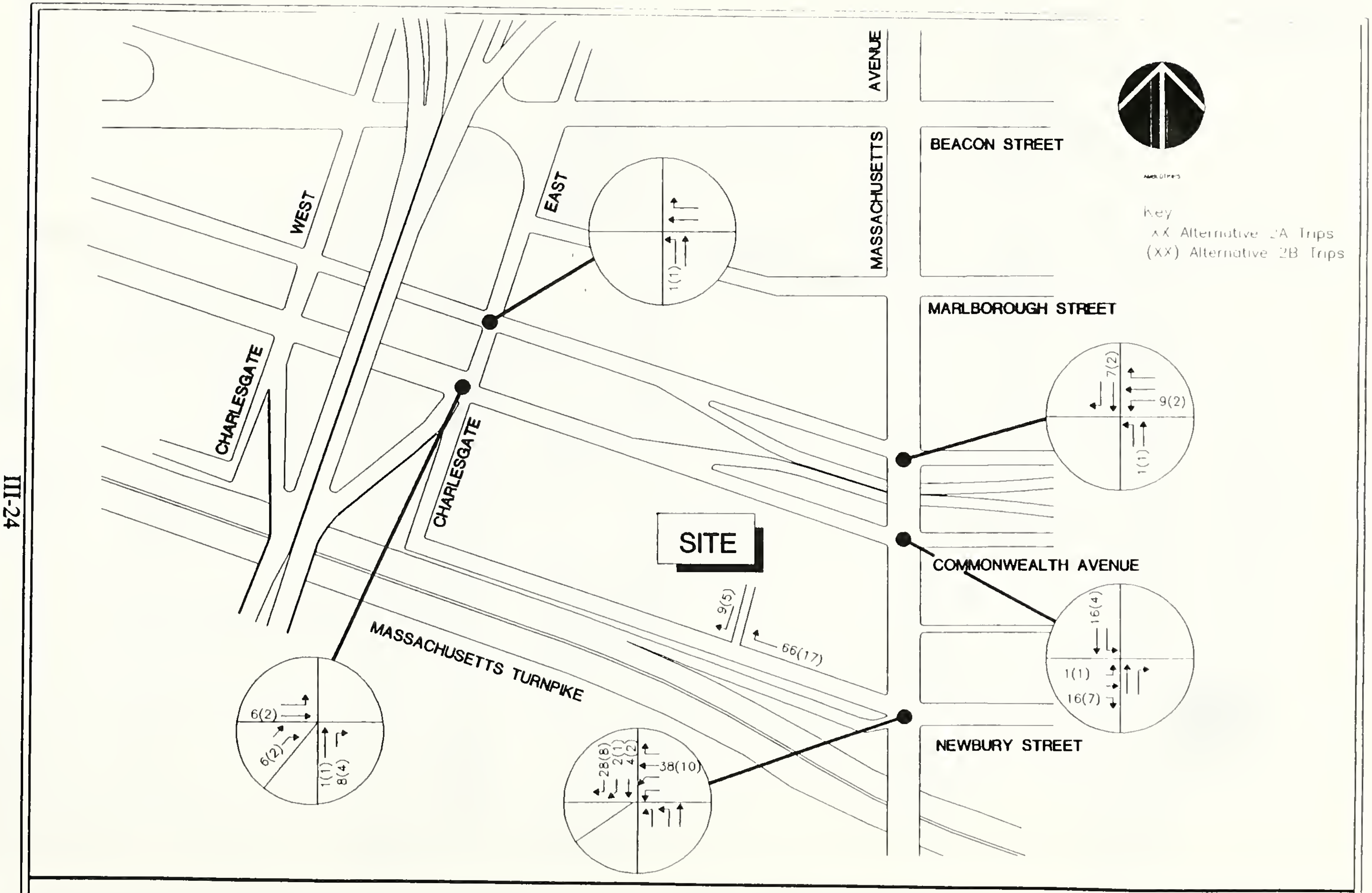

Figure III-10

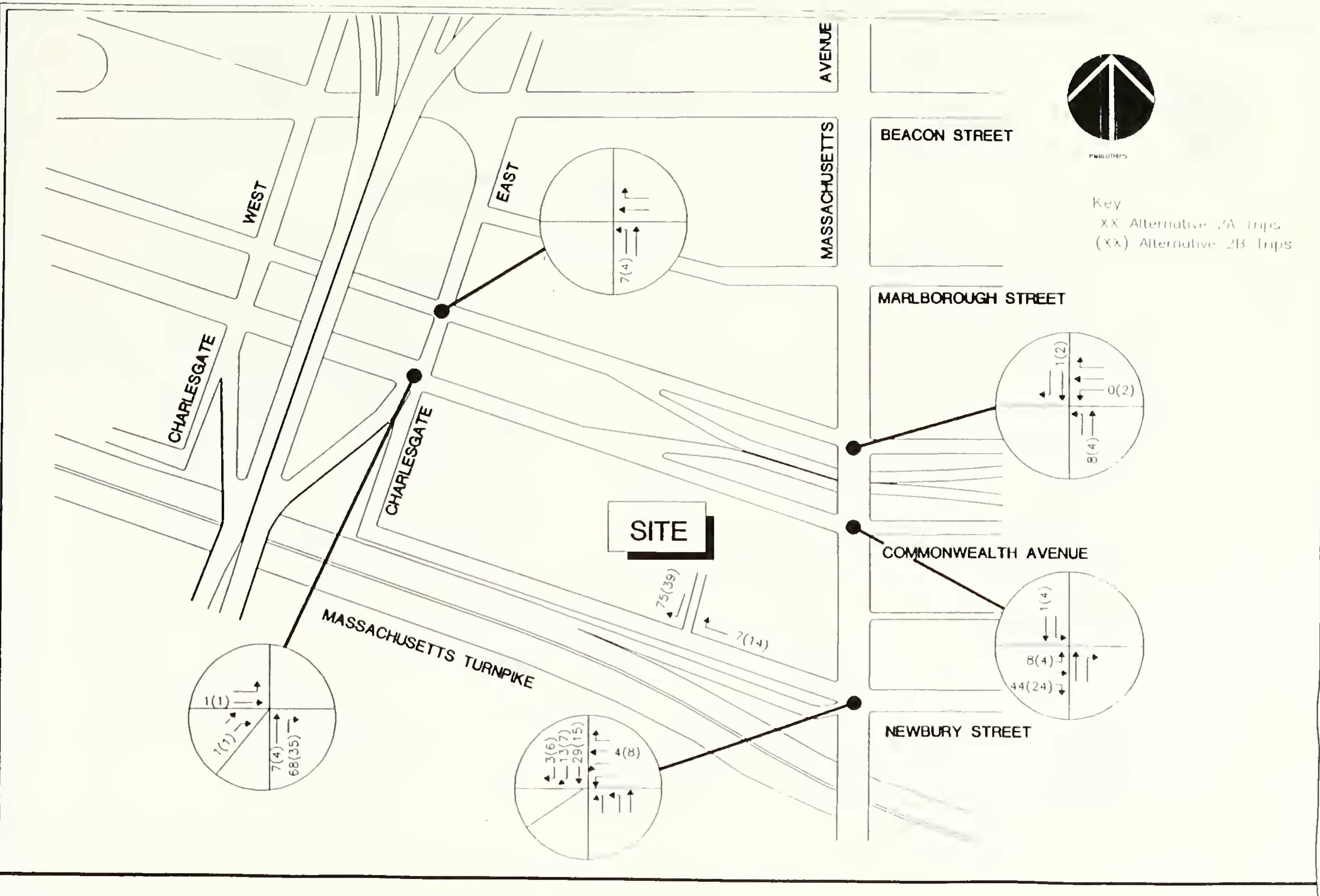

Figure III-11
1994 PM New Peak Hour Site Trips

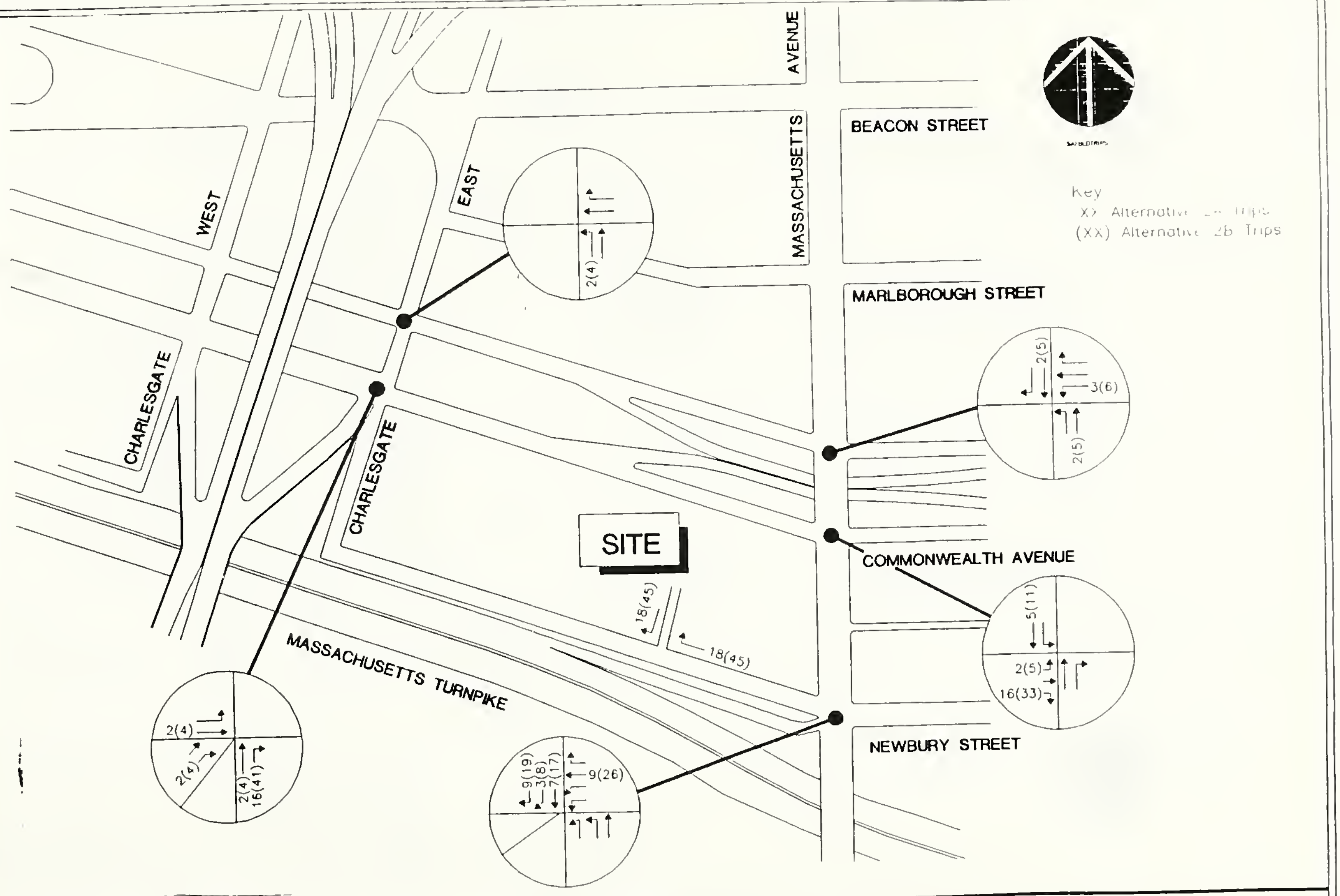

Figure III-12

1994 Saturday New Peak Hour Site Trips

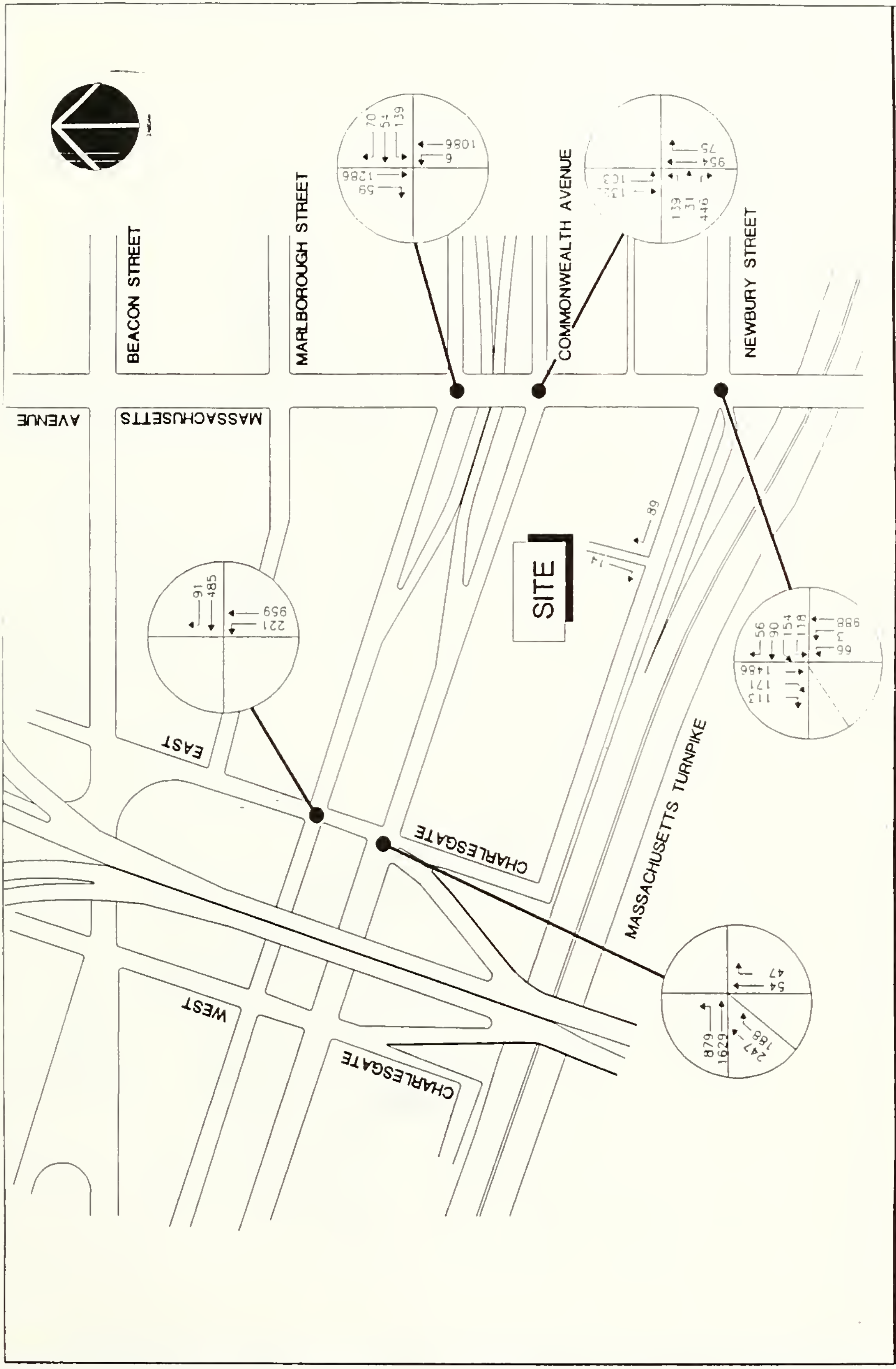

Figure III-13
AM Peak Hour Traffic Volumes
1994 Build Alternative 2A

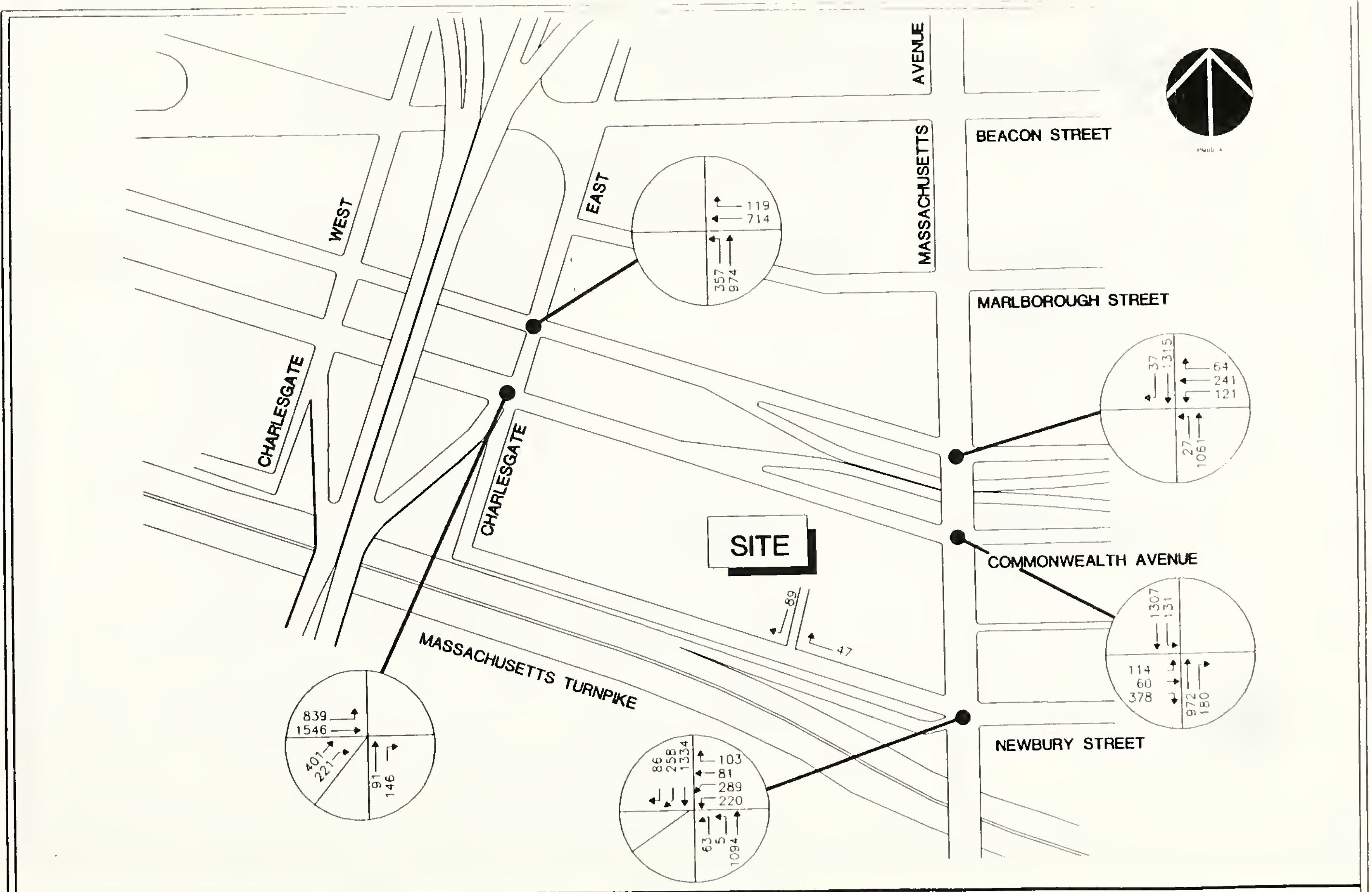

Figure III-14

PM Peak Hour Traffic Volumes

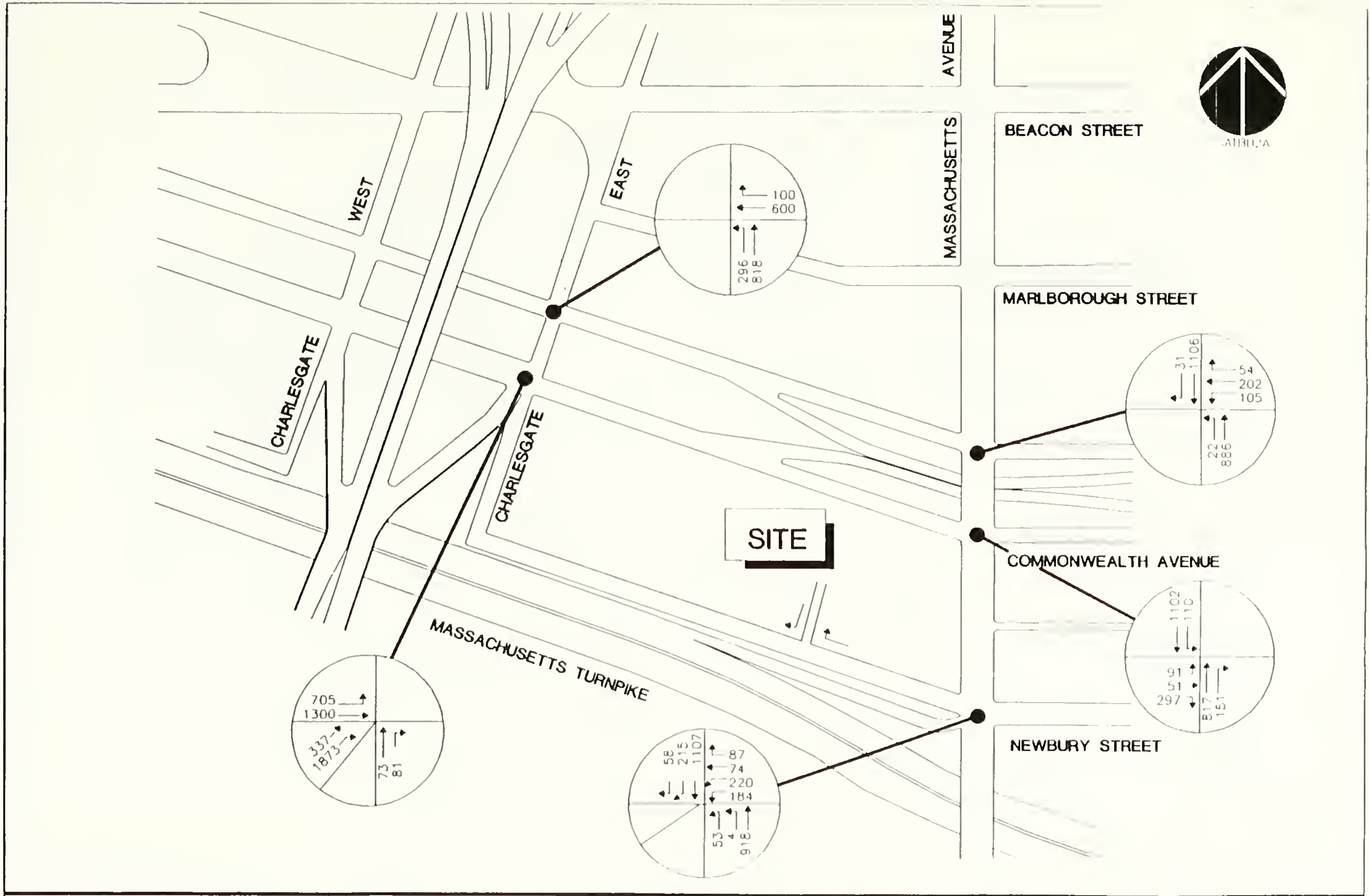

Figure III-15

Saturday Peak Hour Traffic Volumes

1994 Build Alternative 2A

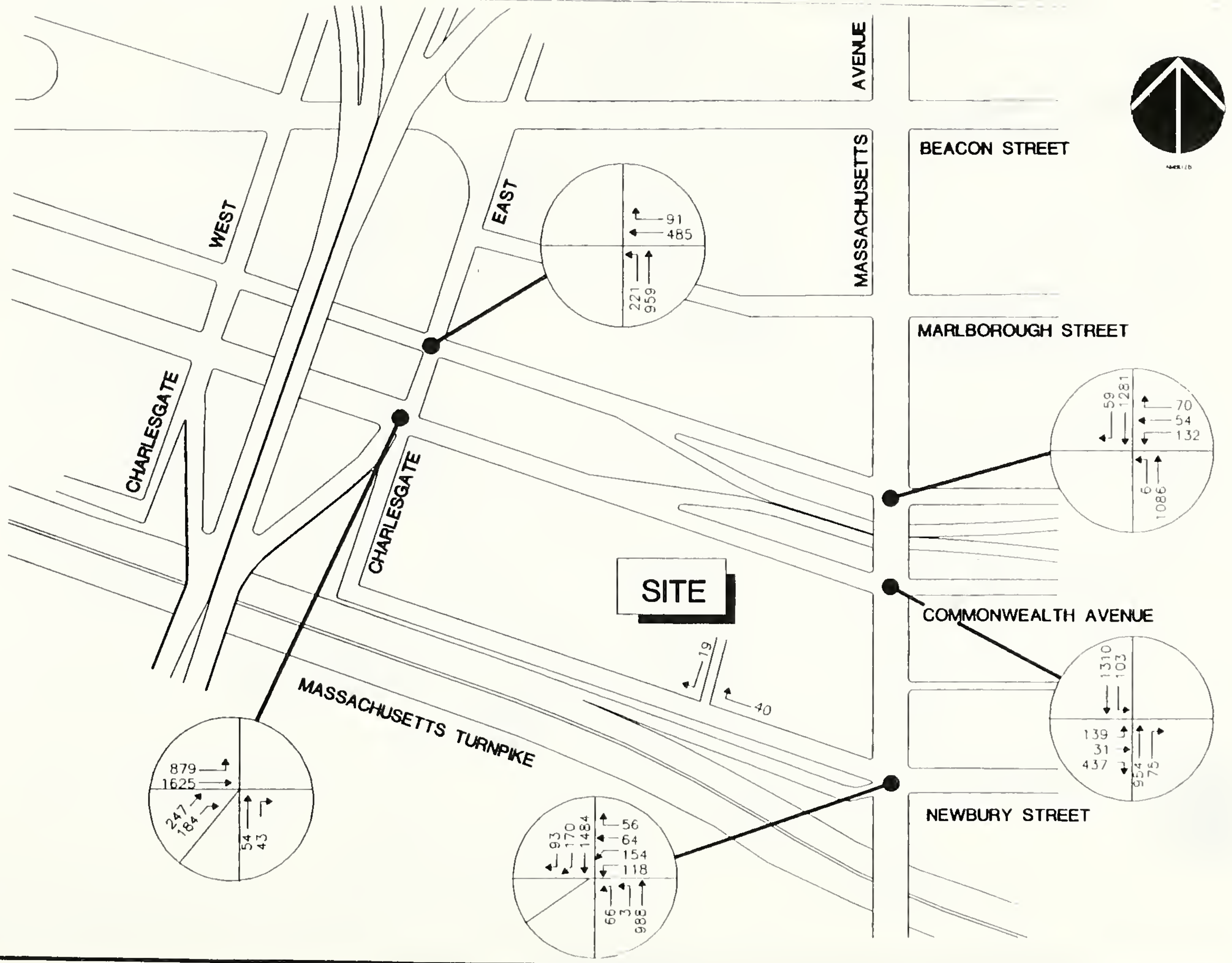

Figure III-16

AM Peak Hour Traffic Volumes

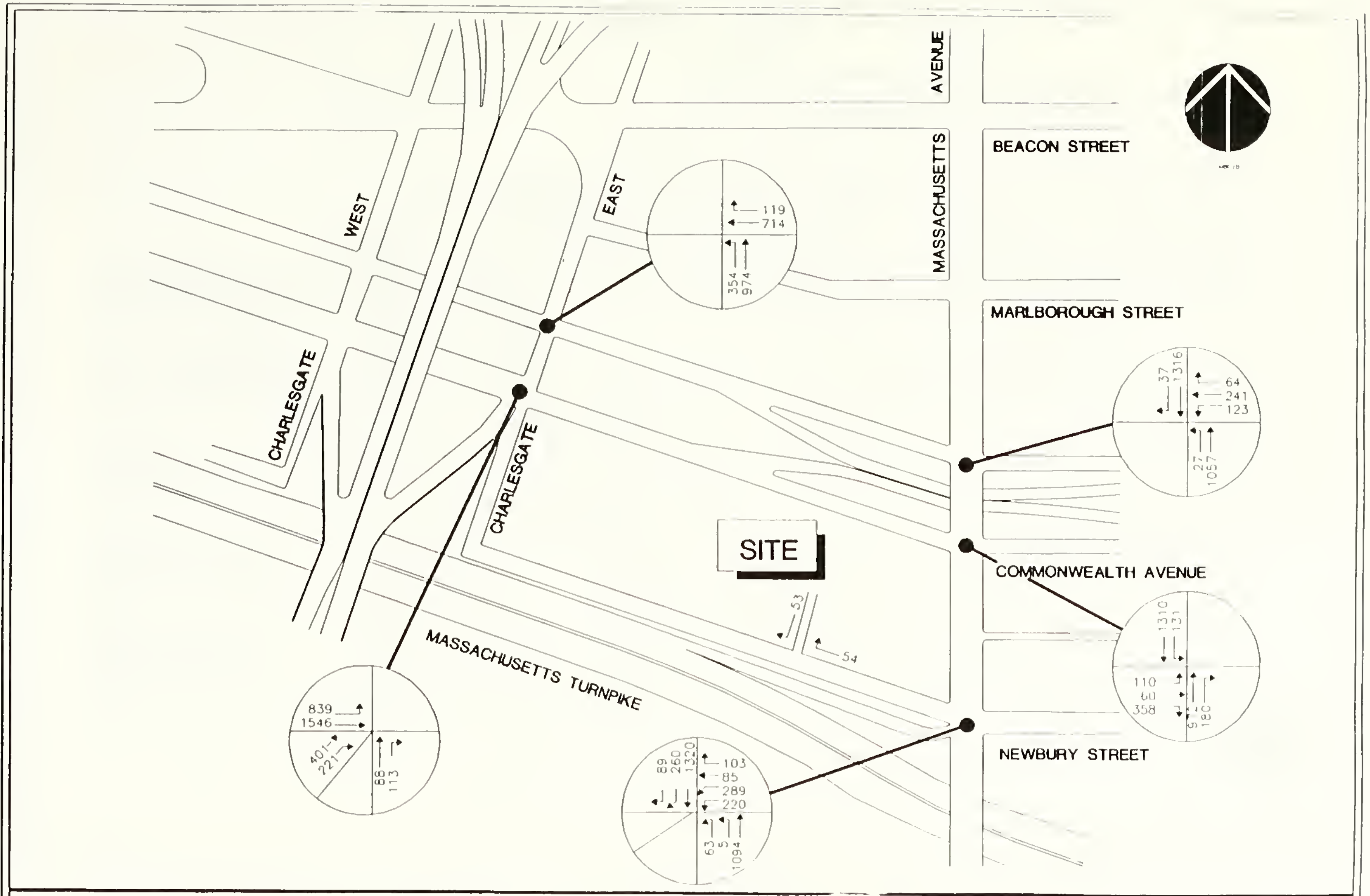

Figure III-17
PM Peak Hour Traffic Volumes
1994 Build Alternative 2B

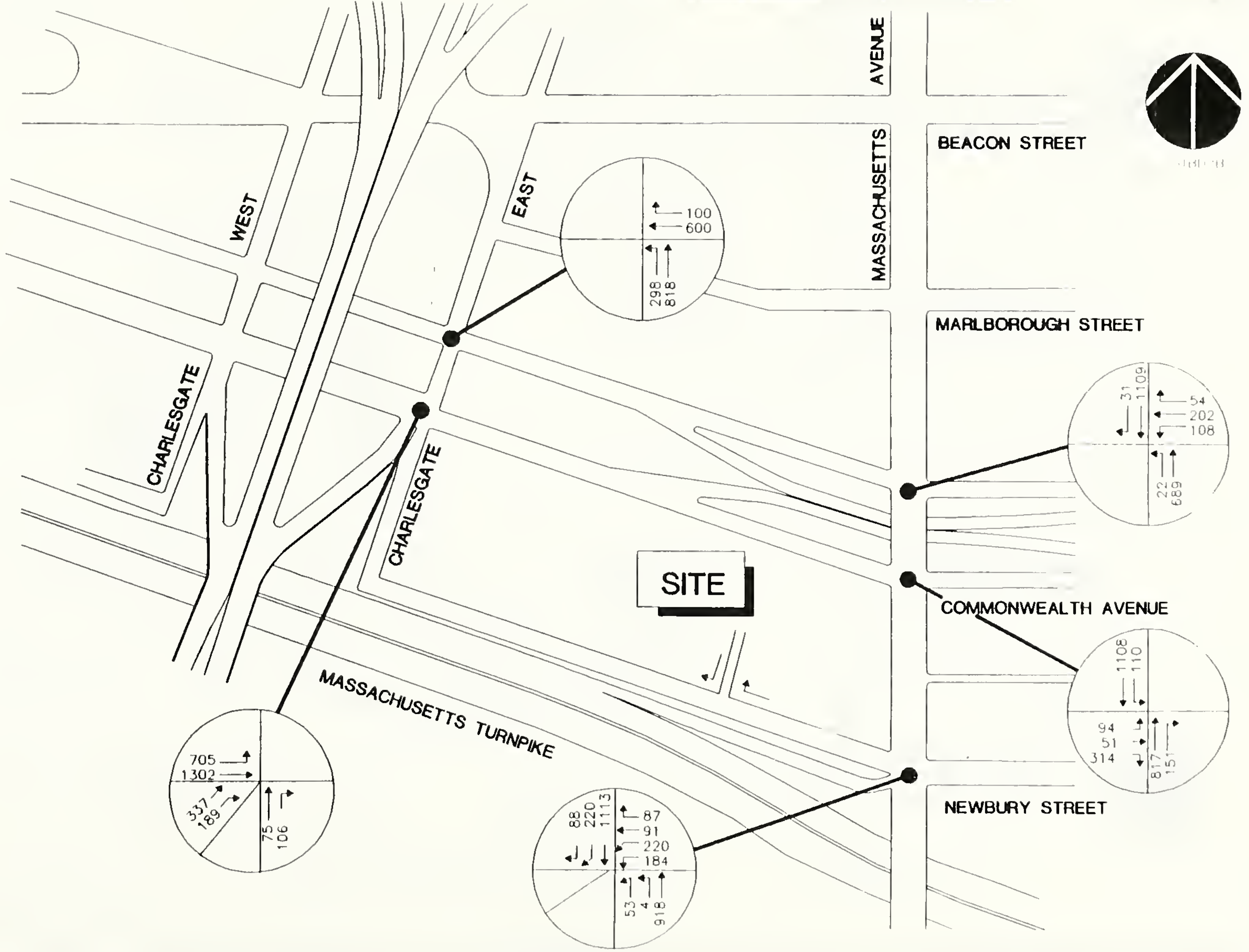

Figure III-18

Saturday Peak Hour Traffic Volumes

Intersection	Peak Hour	Existing LOS	Existing Avg. Delay (Sec./Veh.)	1994 No Build LOS	1994 No Build Avg. Delay (Sec./Veh.)	1994 BD Alt. 2A LOS	1994 BD Alt. 2A Avg. Delay (Sec./Veh.)	1994 BD Alt. 2B LOS	1994 BD Alt. 2B Avg. Delay (Sec./Veh.)
#1: Charlesgate East/	AM	C	15.3	C	18.2	C	18.2	C	18.2
Comm. Ave. WB	PM	C	17.7	C	18.6	C	18.7	C	18.6
	SAT	B	12.8	B	13.5	B	13.5	B	13.5
#2: Charlesgate East/	AM	F	130.8	F	143.7	F	146.3	F	144.5
Comm. Ave. EB	PM	F	149.0	F	174.9	F	294.3	F	216.3
	SAT	D	39.6	E	46.7	E	48.8	E	55.4
#3: Mass. Ave./	AM	C	18.4	B	10.8	B	13.3	B	11.9
Newbury St.	PM	E	48.7	D	31.4	D	32.6	D	33.3
	SAT	C	17.9	C	16.3	C	16.9	C	17.8
#4: Mass. Ave/	AM	D	36.5	B	11.0	B	11.6	B	11.2
Comm. Ave. EB	PM	F	90.2	B	9.2	B	10.4	B	10.1
	SAT	B	11.5	B	6.8	B	7.2	B	7.5
#5: Mass. Ave/	AM	B	6.9	A	4.8	A	4.9	A	4.8
Comm. Ave. WB	PM	D	37.7	B	9.2	B	9.2	B	9.2
	SAT	B	9.4	B	7.2	B	7.4	B	7.3

Table III-7

1994 Build Traffic Operations

4.6 Other Traffic Impacts

Due to the relatively few new trips expected to be generated by the proposed garage, no mid-block congestion should result from this project. In fact, the congestion that is reported to occur at the present lot's entrance when it is filled near capacity will be virtually eliminated. The proposed design of the parking garage will position the ticket gate towards the back of the site. This layout will allow approximately four vehicles to queue within the confines of the site itself before Newbury Street is affected. The maximum number of vehicles entering the garage during the peak commuter hours occurs during the AM peak hour under Alternative 2B when 66 new vehicles are estimated to enter the garage. From parking studies conducted for the exisiting Harvard Club surface lot, it is known that an average of 47 Club related vehicles enter the existing lot during the same time period. Therefore the total number of vehicles entering the proposed garage during the AM peak hour is estimated to be 113 vehicles. Assuming a random arrival rate and a wait time at the ticket gate of 10 seconds it is estimated that 95 percent of the time the vehicle queue will be two cars or less. Since a queue of this length can easily be accomodated on site, it is anticipated that no back-up of traffic onto Newbury Street will occur during the AM peak hours. During the PM and Saturday peak hours the number of vehicles entering are even less, resulting in shorter queues.

The actual peak number of trips arriving at the site occurs outside of either the AM or PM peak hours. Studies of the existing lot show that the peak arrival period for Club patrons is typically from 6:00 to 7:00 PM. It was found that over the course of three separate days, that the number of cars parked between 6:00 and 7:00 PM averaged 43 cars. This number does not include those vehicles turned away due to the lack of parking spaces. It has been reported that because of existing queues due to people waiting to get into the lot and due to the location of the entrance, queues sometimes extend to Massachusetts Avenue. With the proposed garage the queue will be reduced. Assuming that the number of cars arriving increases proportionally with the number of new spaces, a total of 170 cars would arrive with the availability of 430 spaces. Using the same assumptions as were used for estimating the queue for the AM peak, it is estimated that the 95th percentile queue length will be seven cars. This means that three or less cars can be expected to be queued up onto Newbury Street 95 percent of the time. As described below in further detail, the proposed elimination of the metered spaces on Newbury Street will allow space on-street for queuing without blocking traffic flow on Newbury Street.

The number of truck and service vehicle trips to and from the site will not change as a result of the proposed garage. Access to the back of the Club for loading and deliveries will continue as at present. Because the peak garage time is between 6:00 and 7:00, loading and deliveries will not conflict with peak garage times.

4.7 Mitigation

The impact of queues at the garage entrance on Newbury Street can be minimized by removing the eight metered spaces on the north side of Newbury Street, between the existing entrance and Massachusetts Avenue. As described above, this will allow space on-street for vehicles entering the garage to queue, without blocking through traffic on Newbury Street. The City would be reimbursed for the parking revenues lost due to the elimination of these eight spaces.

The Harvard Club, in an effort to reduce vehicle trips in the Back Bay Neighborhood, will actively encourage club patrons to use the MBTA and carpool through their newsletter, announcements of events, and the formation of a transportation committee. The close proximity of the Club to the Auditorium T-stop on Newbury Street makes the use of transit by club patrons extremely convenient.

The Harvard Club is also a member of the Back Bay Transportation Management Association and will work with them to promote public transportation and coordinate and cooperate with other transportation improvements in the Back Bay.

5.0 PARKING MANAGEMENT ELEMENT

5.1 Existing Parking Conditions

Currently within the Back Bay Resident Parking District are a total of 1,157 existing off-street parking spaces.* Of these, 497 are private and 660 are public. Within the District there is a total of 4 public facilities (3 lots, 1 garage) and 13 private facilities (7 lots, 6 garages). In 1987, peak occupancy was 653 spaces for the private lots (99% occupancy) and 401 spaces for the public lots (81% occupancy).

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* Boston Transportation Department, 1987 Downtown Boston Parking Inventory Survey, July 1988.

Parking rates averaged $6.00 for one hour, $8.08 for 3 hours, and $10.94 for 8 hours. Monthly rates averaged $175.00 per month.

In the vicinity of the Harvard Club, on-street parking exists along Newbury Street and Commonwealth Avenue. Along Newbury Street between Massachusetts Avenue and Charlesgate East, there are a total of 72 metered spaces.

The nearest public garage to the Harvard Club is the Danker & Donahue Garage on Newbury Street between Hereford Street and Massachusetts Avenue. This facility has a capacity of 500 cars. The Somerset Garage, located directly adjacent to the site originally included 328 public spaces, but the number of spaces available to the public has been severely cut back in order to provide spaces to the residents of the Somerset and Windsor Place. Approximately 120 spaces were privatized when the Somerset was converted to condominiums. Over the past three years, an additional 150 public spaces have also been lost to residents of the Somerset, Windsor Place, and other Back Bay residents. At present, approximately 50 public spaces are left, and it is anticipated that these will also be eventually eliminated.

Recent data supplied by the BTD indicates that the number of vehicles owned in the Back Bay has increased by 54% in the past ten years. This has been primarily a result of the increased numbers of condominium conversions in the area. During this time there has been no expansion in the number of on-street spaces available under the Resident Permit Parking program. This has resulted in an approximate 50% deficit in the number of on-street resident permit parking spaces. The increase in vehicle ownership in the Back Bay and the decrease of public spaces makes parking availability and the construction of the garage more critical.

Other than the expected loss of the remaining public spaces at the Somerset, there are no future changes anticipated to the off-street parking supply.

5.2 Parking Space Allocation

Three parking space allocation scenarios were reviewed for the purposes of gauging variations in potential traffic impacts of the proposed project as follows:

- Alternative 1 - Garage size meeting IPOD regulations. This alternative would provide parking sufficient to meet the demands of only the Harvard Club. During off-peak club hours, some spaces would be available to Back Bay residents.

- Alternative 2A - This alternative would provide a 430 space garage of which 140 would be reserved for Club patrons, 100 designated as short-term spaces, and 190 as long-term, leased spaces.

- Alternative 2B - This alternative would also provide 430 spaces of which 140 would be reserved for Club patrons, 250 short-term, and 40 long-term, leased spaces.

Alternatives 2A and 2B represent two extremes in which short-term and long-term spaces are respecively maximized. As described earlier, the actual allocation of spaces has yet to be determined and will likely fall somewhere between the two in terms of number of spaces allocated to short-term and long-term (resident and non-resident) spaces. It is currently proposed that 100 spaces will be reserved for Back Bay residents, between 140 to 300 spaces will be used for the Club, and the remaining spaces will be used as short term commercial spaces or Club spaces, depending on the time of day. During the day when the commercial demand is greater, a greater portion of the overlap spaces will be used by commercial users and during the evening, a greater portion of the overlap spaces will be used by the Club.

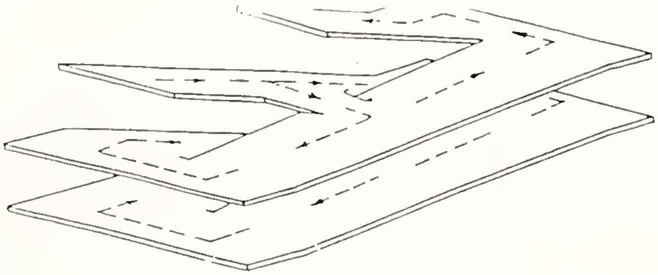
5.3 Parking Plan

Figure III-19 shows the parking layout and the location of the ticket booth/gate for the garage. This layout will be the same for each alternative.

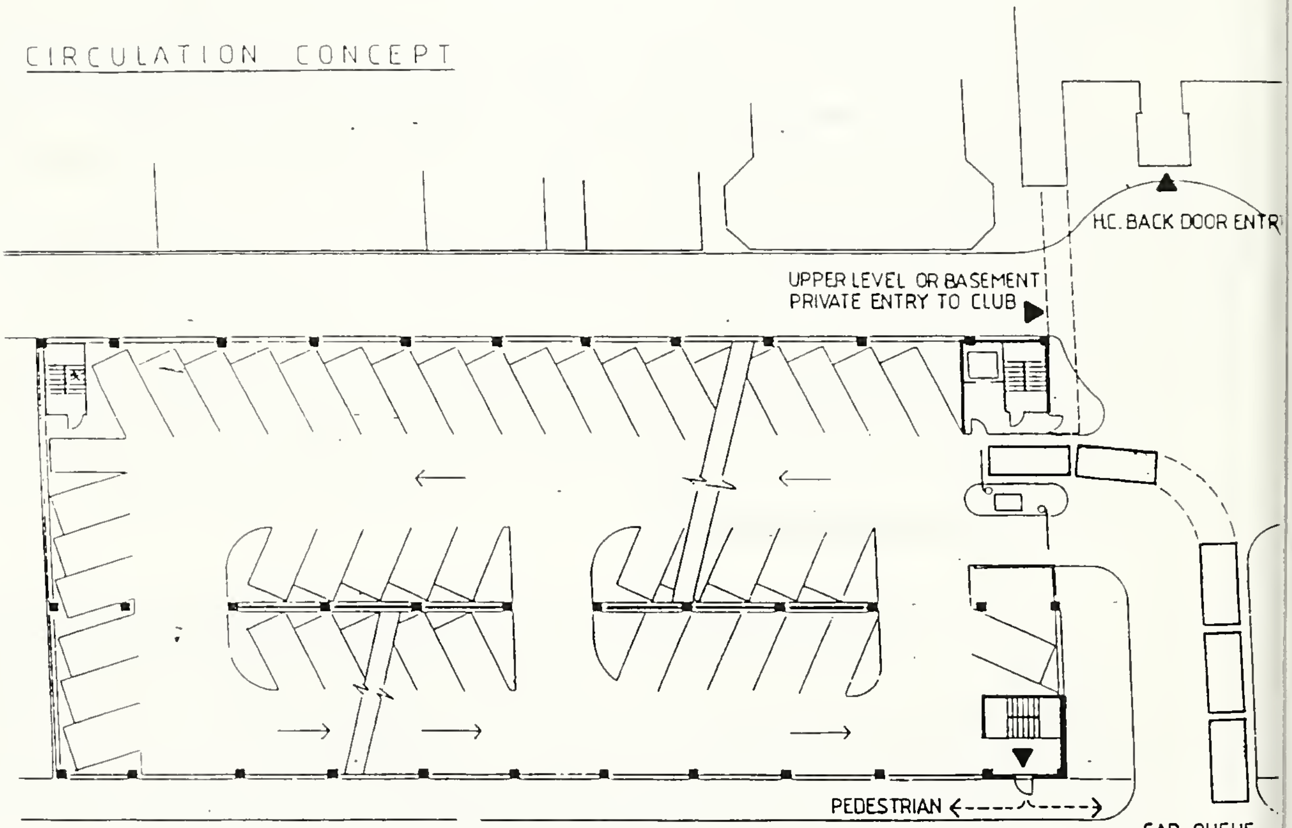
5.4 Parking Management Plan

The two parking alternatives outlined in the BRA Scoping Determination represent two extremes of use for the garage. Alternative 2A, with 100 short-term spaces and 190 monthly spaces, represents the case where monthly lease spaces are favored, while Alternative 2B includes 250 short-term spaces and 40 monthly spaces. During the AM and PM peak commuter hours, neither of these alternatives nor any alternative falling between 2A and 2B will have any significant impact on the surrounding intersections.

As described earlier, the actual allocation of spaces will fall somewhere in between these two extremes. Currently, it is anticipated that approximately 100 spaces will be reserved for residents during all times of the day. The Harvard Club will have 140 spaces reserved at all times. The remaining spaces will be allocated between commercial uses



CIRCULATION CONCEPT



ENTRY LEVEL

MEYER AND MEYER

Figure III-19
Pedestrian and Vehicular Circulation

and the Club, depending on the time of the day. During the day, including the AM and PM peak hours, Club parking demand is minimal and can easily be accommodated by the 140 reserved spaces. During the day when commercial demands are high, the extra spaces will be used by commercial users. Parking demand by the Club typically peaks after 6:00 PM. To accommodate this, commercial overlap parking will be restricted after 6:00 PM and at this time a portion of the overlap spaces will be used by Club attendees.

The rate structure for the facility will be dictated in part by market conditions. The rates for Harvard Club members will remain as at present. Monthly rates will be approximately $200.00 per month, which is typical for the Back Bay area. Commercial rates will be $2.00 per 30 minutes up to a maximum of $9.00, with a 10-hour limit or $11.00 for 24 hours. Overnight only (resident) parkers may receive a reduced rate.

6.0 PEDESTRIAN CIRCULATION

The section of Newbury Street between Massachusetts Avenue and Charlesgate East is marked by an almost complete absence of the pedestrian traffic which exists on Newbury Street from Arlington Street to Massachusetts Avenue. There are no retail or commercial uses on the block to attract pedestrians, and it is unlikely that there will be a demand for any in the near future. Pedestrians travelling from the Back Bay to the Kenmore Square area tend to use Commonwealth Avenue. The occasional pedestrian is travelling to or from the cars parked on Newbury Street or the adjacent parking facilities, for the purpose of:

1) Shopping on Newbury Street;
2) Visiting a residence or office on Commonwealth Avenue; or
3) Attending a baseball game at Fenway Park.

The Greenline Auditorium Station is near the site, across the intersection of Newbury Street and Massachusetts Avenue. Through advertising by the Club, usage of the "T" may increase, but will have a minimal impact on pedestrian circulation.

The proposed garage will increase the pedestrian traffic along Newbury Street as a result of the additional short- and long-term commercial and residential spaces, but this pedestrian traffic will not be simultaneous with peak garage periods or peak traffic periods. An exit directly to Newbury Street will be provided at the base of the Eastern stair tower.

Entrance to the Club will remain as it is through the security doors of the newly remodeled back door. In order to minimize the potential conflict between pedestrians and vehicles entering and exiting the garage, warning signs and markings will be installed. The reduced queueing onto Newbury Street as a result of the garage and the location of the entrance will minimize potential pedestrian conflicts with automobiles entering the garage.

Significant design is scheduled for ramp screening, landscaping and finishes for the alley and alley side of the garage. In addition, lighting consultants have been retained to ensure safe and aesthetic lighting for all spaces surrounding the garage.

7.0 LOADING

The proposed garage does not create additional loading needs over the existing lot. In addition, the design of the garage allows loading and servicing to continue as it does with the existing lot, as shown on Figure III-20. Service trucks will nose into the alley from the Harvard Club entry drive and back into the Harvard Club service dock northeast of the proposed garage entry. Miscellaneous truck and van loading will continue in the alley all the way to Windsor Place, west of the garage. Garbage trucks will continue their practice of backing down the alley from the Harvard Club turnaround. The maneuvering radius for vehicles attempting one-pass turns into the alley is approximately 45 feet. The loading plan will not require any backing out onto the street or additional curb-cuts.

8.0 CONSTRUCTION IMPACTS

A more detailed description of Construction Impacts is included in Section 6.0 of the Environmental Protection Component.

8.1 Construction Activity Schedule

The construction period for the proposed Harvard Club Garage project is expected to last approximately eight months beginning in the second quarter of 1991 with expected completion in the first quarter of 1992. Typical construction hours for the project will be from 7:00 AM to 3:30 PM, Monday through Friday and occasionally on Saturday. A preliminary construction schedule is shown on Figure IV-6 in Section 6.2 of the Environmental Protection Component.

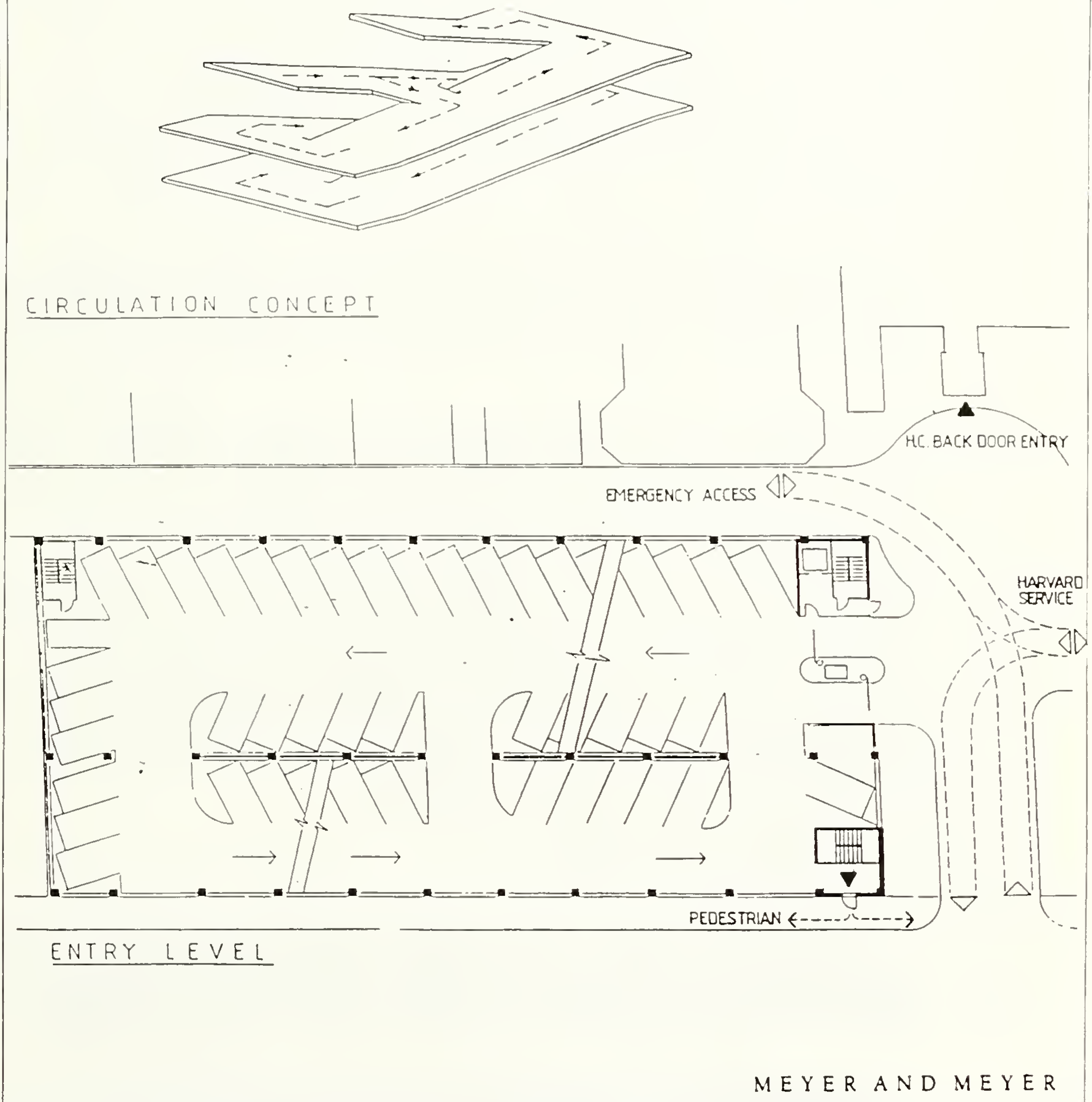


Figure III-20
Service and Emergency Site Access

8.2 Construction Employee Trip Generation

The number of construction workers will vary, but is estimated not to exceed 35 workers at one time. Trip generation for construction activities is a direct function of the number of construction workers. Assuming an auto occupancy of two persons per vehicle,* the 35 workers will generate 18 one-way trips. Due to the site's close proximity to the MBTA Green Line and bus routes, it can be expected that many of the construction workers will use public transportation, thereby further reducing the number of trips. In addition, construction workers generally travel before the peak hours (work day - 7:00 AM to 3:30 PM) and will not add to peak hour traffic volumes. As a result, no significant impacts to the study area roadway system are anticipated from construction worker vehicle traffic.

Construction workers will be encouraged to use public transportation. Ample secured storage for tools will be provided on-site so that workers will not need to transport their tools to and from the site on a daily basis. This will alleviate the need to drive to the site.

In order to discourage driving to the site, no on-site parking will be available for personal vehicles. Past experience shows that the lack of free or subsidized parking discourages use of personal vehicles and increases carpooling. For those who must drive, several parking garages exist within walking distance of the job site.

In addition, bulletin boards located around the site will be used to post bus schedules, train schedules, and car-pooling information. Efforts will be made to optimize construction workers' use of all available means of alternative transportation.

The peak demand for workers should occur during the second quarter of 1991. The remainder of the construction period will demand fewer workers at any one time. The relatively small number of vehicles that may be used during the construction period should be absorbed by the parking facilities near the site.

8.3 Truck Routes and Volumes

Trucks will be needed to remove material excavated from the site and to deliver construction materials to the site. The trucks removing excavated material and trucks delivering steel are anticipated to be eighteen wheel trucks. Truck traffic will vary throughout the construction period, depending on the activity. The volumes described below are estimates and may be refined as the construction schedule becomes finalized.

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* A relatively high auto occupancy rate is assumed due to the limited parking in the area, the cost of parking, and the increased inclination of construction workers to carpool.

The largest anticipated number of construction trucks will be for the excavation and concrete operation. Approximately 20 trucks per day, every third day, will be used for the concrete operation. During excavation, there will also be approximately 20 trucks per day going to the site. The period of excavation requiring the 20 trucks per day will be completed prior to the concrete pouring also requiring 20 trucks per day. The excavation and concrete operation is expected to last approximately 2½ months, and should occur during the second quarter of 1991 through the third quarter of 1991. This volume is expected to decrease to 4 trucks per day beginning in the third quarter of 1991 and continue through completion.

The impacts caused by construction trucks during the evening peak hour are expected to be minimal because deliveries will be completed prior to the PM peak hour. Morning peak hour impacts are expected to be minor due to deliveries being spread uniformly during the work day. A maximum of 20 trucks per day at the Harvard Club Garage site translates to less than 3 trucks per hour if distributed uniformly over an eight-hour day.

Limiting the impacts of construction traffic and truck noise on the adjacent neighborhood and taking advantage of the site's close proximity to the Massachusetts Turnpike were the most important factors in determing the truck routes. Enforcement of truck routes will be accomplished through clauses in the contractors' and subcontractors' agreements. The proposed route is shown on Figure IV-9 in the Construction Impacts section of the Environmental Protection Component. Clauses in subcontractors agreements and the issuance of truck route maps are anticipated to eliminate construction truck travel through Kenmore Square. The existing one way clockwise traffic pattern upon entering the Newbury Street extension returns the traffic to Massachusetts Avenue. From Massachusetts Avenue, the trucks can go north along Massachusetts Avenue into Cambridge, west onto the Massachusetts Turnpike via the on-ramp at Massachusetts Avenue and Newbury Street, east along Boylston Street into Boston, or south along Massachusetts Avenue to the Southeast Expressway. To arrive at the site, trucks may exit the Massachusetts Turnpike at the Prudential exit, travel along Belvidere to Dalton Streets, across Boylston Street to Hereford Street, and onto Newbury Street. From the Southeast Expressway, trucks will travel north along Massachusetts Avenue to east on Boylston Street, and north on Hereford Street to Newbury Street.

8.4 Street and Sidewalk Closure and Staging

During construction of the proposed project, portions of the sidewalk and street adjacent to the site will need to be closed to pedestrians and automobiles. A more detailed description of perimeter protection and pedestrian safety, construction material handling, and traffic rerouting is included in Section 6.3 of the Construction Impacts section of the Environmental Protection Component. As described in the Construction Impacts section, a detailed construction plan will be included in the Construction Management Plan required by the BTD prior to the start of construction.

The Harvard Club will work with the BTD and other appropriate agencies to finalize the plan. The staging plan, including street and sidewalk closures, described below, are subject to change based on further discussions with the BTD and other appropriate agencies.

A portion of the sidewalk, the length of the garage site, on the northern side of Newbury Street, will be closed to pedestrians during construction. There will be appropriate signing to instruct pedestrians to the southern side of the street. One lane of Newbury Street will also be closed to automobile traffic to allow for staging for the project. One lane of traffic, however, will be maintained throughout construction.

8.5 Public Safety

Access to the construction areas will be limited by perimeter controls, such as temporary construction fencing. Easily understandable signage will be provided to ensure safe pedestrian routing around and through the site.

Additional safety measures will be described in detail in the Construction Management Plan to be approved prior to construction.

8.6 Parking During Construction of Garage

The Harvard Club has obtained commitments from nearby garages to reserve existing surplus parking spaces for Club members during construction. Because this will tighten the number of available parking spaces, this will only be tolerable for the short construction period.

8.7 Liaison

The Harvard Club development team will assign an individual as the primary contact to work with the appropriate public review agencies and the surrounding businesses and communities. The role of the liaison is enable the construction period to run as smoothly as possible by serving as the point of contact for resolution of any issue which may occur.

9.0 MONITORING

After completion of the Harvard Club Garage, the Club will initiate a program to monitor the travel behavior of the users of the garage. Vehicle occupancy rate, type of user (Club, residential, commercial), and origin-destination information will be gathered. In part, the information will be used to ensure that the changing needs of the Club, the neighborhood residents, and commercial interests are met.

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IV. Environmental Protection Component

IV. ENVIRONMENTAL PROTECTION COMPONENT

1.0 AIR QUALITY ANALYSIS

1.1 Objective

The objective of the air quality analysis is to verify that, with construction of the proposed Harvard Club Garage project, the Massachusetts and National Ambient Air Quality Standards (NAAQS) for carbon monoxide (CO) will be maintained. CO is used in this analysis as an indicator of roadway air pollution levels, since it is the most abundant pollutant emitted by motor vehicles. NAAQS for carbon monoxide have been set by the U.S. Environmental Protection Agency (EPA). Standards for the Commonwealth of Massachusetts are identical to the Federal standards. The primary CO standards, designed to protect the public health, set a maximum concentration of 35 parts per million (ppm) for a one-hour period, and 9 ppm for eight hours, each not to be exceeded more than once per year.

To demonstrate compliance, it is necessary to identify the areas of human activity (sensitive receptors) exposed to maximum air pollutant levels from motor vehicle emissions in the project area. Using air quality modeling techniques, CO levels are estimated at these sensitive receptors with and without the proposed project. Projected pollutant levels are then compared to the NAAQS. The air quality analysis is based on a modeling protocol approved by the Boston Redevelopment Authority.*

1.2 Background Air Quality

An air quality analysis requires an estimate of "background" air quality levels. Background levels reflect the contribution of all sources in the project area less the specific intersections and garage analyzed. For analysis purposes, background CO levels in the project area were determined by the Massachusetts Department of Environmental Protection (DEP) as 5.0 ppm (1-hour average), and 3.0 ppm (8-hour average) for the peak one-hour and eight hour periods, respectively. These values were also assumed for future years in the analysis.

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* Personal Communication, Mr. Richard Mertens, Boston Redevelopment Authority (BRA), June 6, 1990.

1.3 Study Approach

The Harvard Club Garage air quality analysis was based on BRA* recommended procedures. The analysis calculated maximum one-hour and eight-hour CO concentrations at sensitive receptors located adjacent to three key intersections in the project area for the following three cases:

Case No.	Year	Project Alternative
1	1990	Existing
2	1994	No-Build
3	1994	Build

For each case, the EPA MOBILE4** and CAL3QHC*** computer programs were used to calculate motor vehicle emissions and CO concentrations at intersections. Emissions data calculated by the MOBILE4 model were based on motor vehicle operating conditions typical of peak one-hour and eight-hour periods. In addition, the analysis incorporated the effects of the Commonwealth's statewide inspection and maintenance (I&M) program designed to control emissions of CO from motor vehicles. These emissions data were used as input to the CAL3QHC model to predict CO concentrations. MOBILE4 and CAL3QHC modeling methodologies are detailed in Appendix F.

In addition to the intersection analysis, an analysis was performed for the 1994 Build case to determine impacts of the proposed parking facility. The analysis of the parking garage utilized MOBILE4 and CAL3QHC to calculate CO impacts at two receptors near the garage. Modeling methodology and assumptions are detailed in Appendix F.

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* Personal Communication, Mr. Richard Mertens, Boston Redevelopment Authority (BRA), June 6, 1990.

** EPA, User's Guide to MOBILE4: Mobile Source Emissions Factor Model, EPA-AA-TEB-89-01, Ann Arbor, MI, February, 1989.

*** Parsons, Brinkerhoff Quade & Douglas, Inc., "CAL3QHC: Modified Version of USEPA's CAL3Q Program," January, 1989.

Since CO emissions are greatest at roadway intersections due to vehicle idling, acceleration and deceleration, this analysis examines the maximum predicted CO levels at areas in close proximity to intersections in the project study area. The air quality analysis examined CO levels at the following three intersections:

- o Massachusetts Avenue/Newbury Street
- o Massachusetts Avenue/Commonwealth Avenue
- o Commonwealth Avenue/Charlesgate East

Consistent with EPA Guidelines,* receptor locations were located where maximum carbon monoxide concentrations are likely to occur (i.e., adjacent to intersection vehicle queues), and where the general public is likely to have access. The intersection geometry and receptor locations at the three intersections analyzed are shown in Figures IV-1 through IV-3. All intersections are signalized.

In addition, air quality impacts were modeled at two receptors located at the Newbury Street entrance to the Harvard Club and on the sidewalk directly in front of the proposed garage on Newbury Street. Garage and receptor locations for the Harvard Club Garage analysis are shown in Figure IV-4.

Based on traffic data generated for the Transportation Component of this report, the peak weekday PM traffic hour was selected for the one-hour analysis of all three intersections because it represented the worst case traffic conditions. Peak eight-hour volumes for approaches at the three intersections were calculated by factoring the peak one-hour traffic data to reflect the average hour in the peak eight-hour period. A peak eight-hour to one-hour factor of 0.81 was used for the two Massachusetts Avenue intersections and a factor of 0.76 was used at the Commonwealth/Charlesgate East intersection. These factors were based on past studies in the area.

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* EPA, Guidelines for Air Quality Maintenance Planning and Analysis Volume 9, (Revised): Evaluating Indirect Sources, Second Printing, EPA-450/4-78-001, Research Triangle Park.

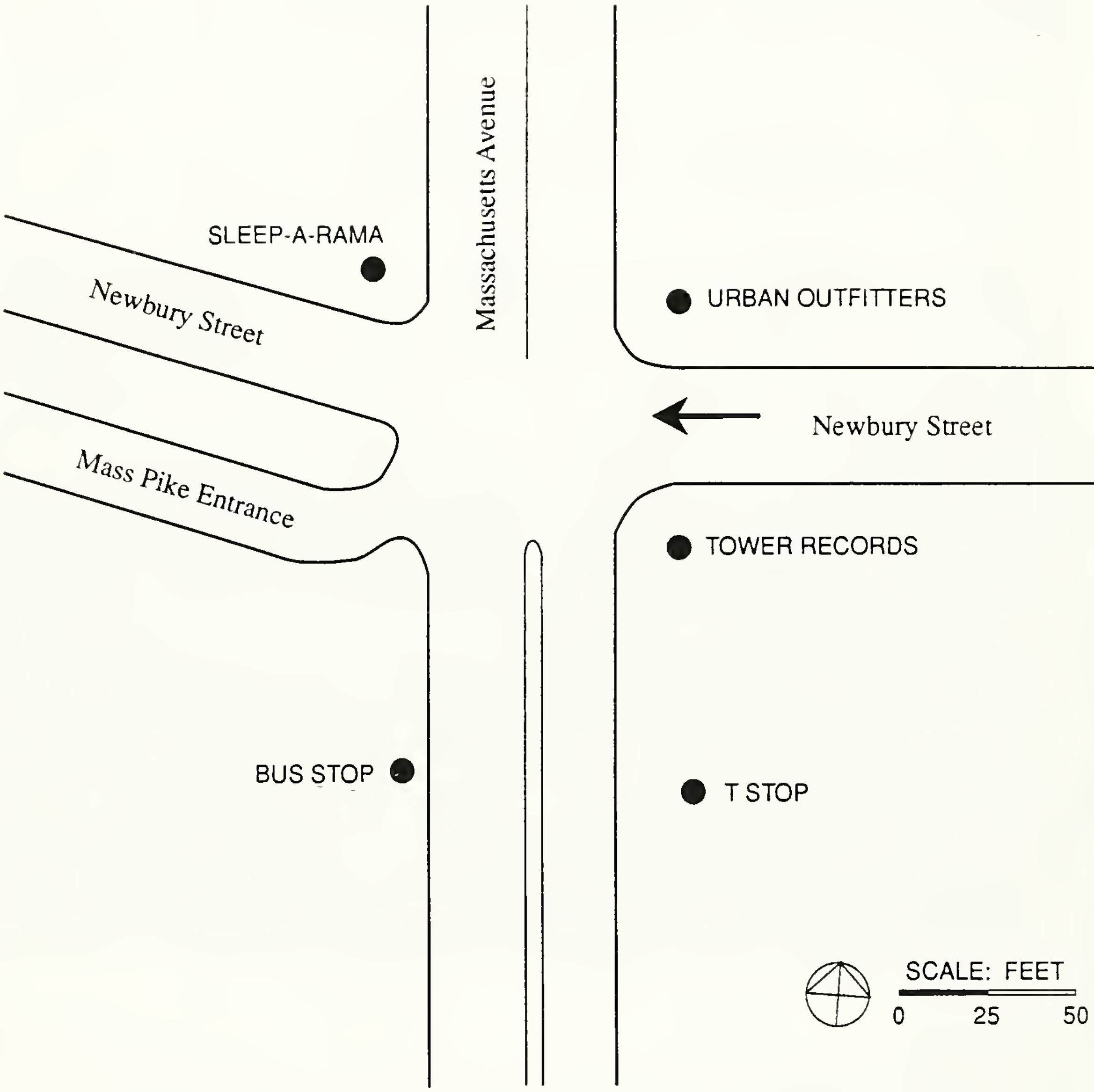

Figure IV-1
Massachusetts Avenue / Newbury Street

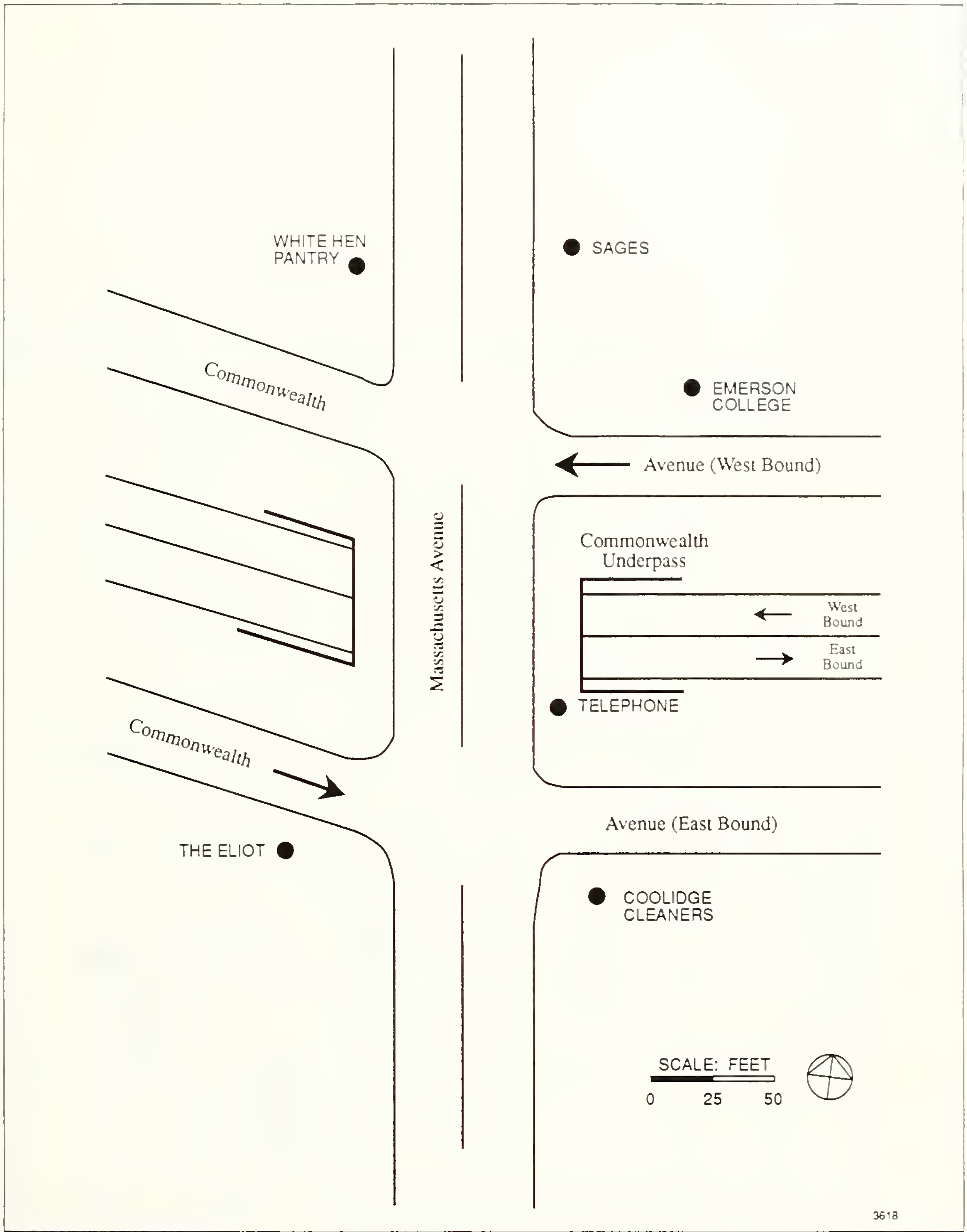

Figure IV-2
Massachusetts Avenue / Commonwealth Avenue

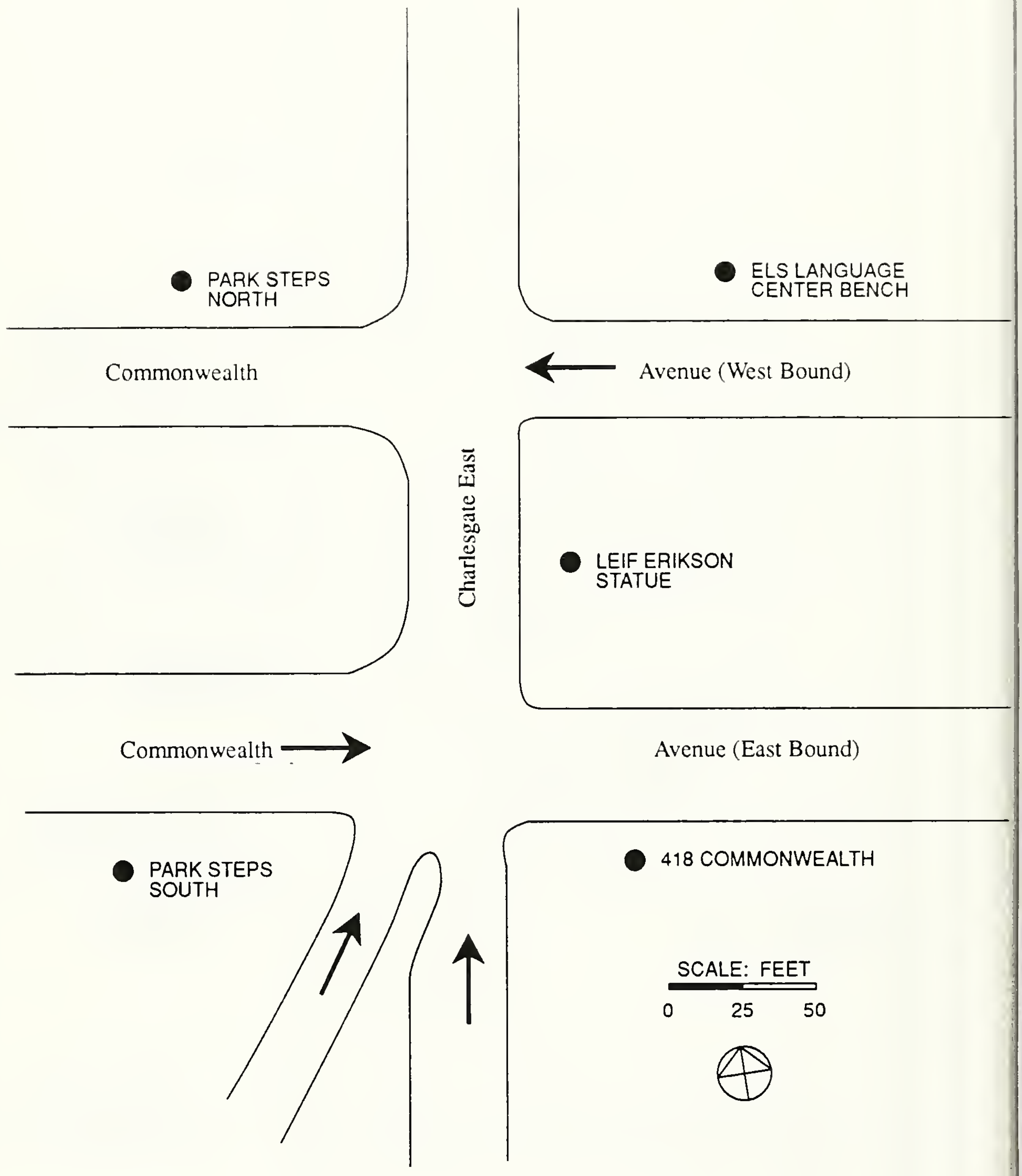

Figure IV-3
Commonwealth Avenue / Charlesgate East

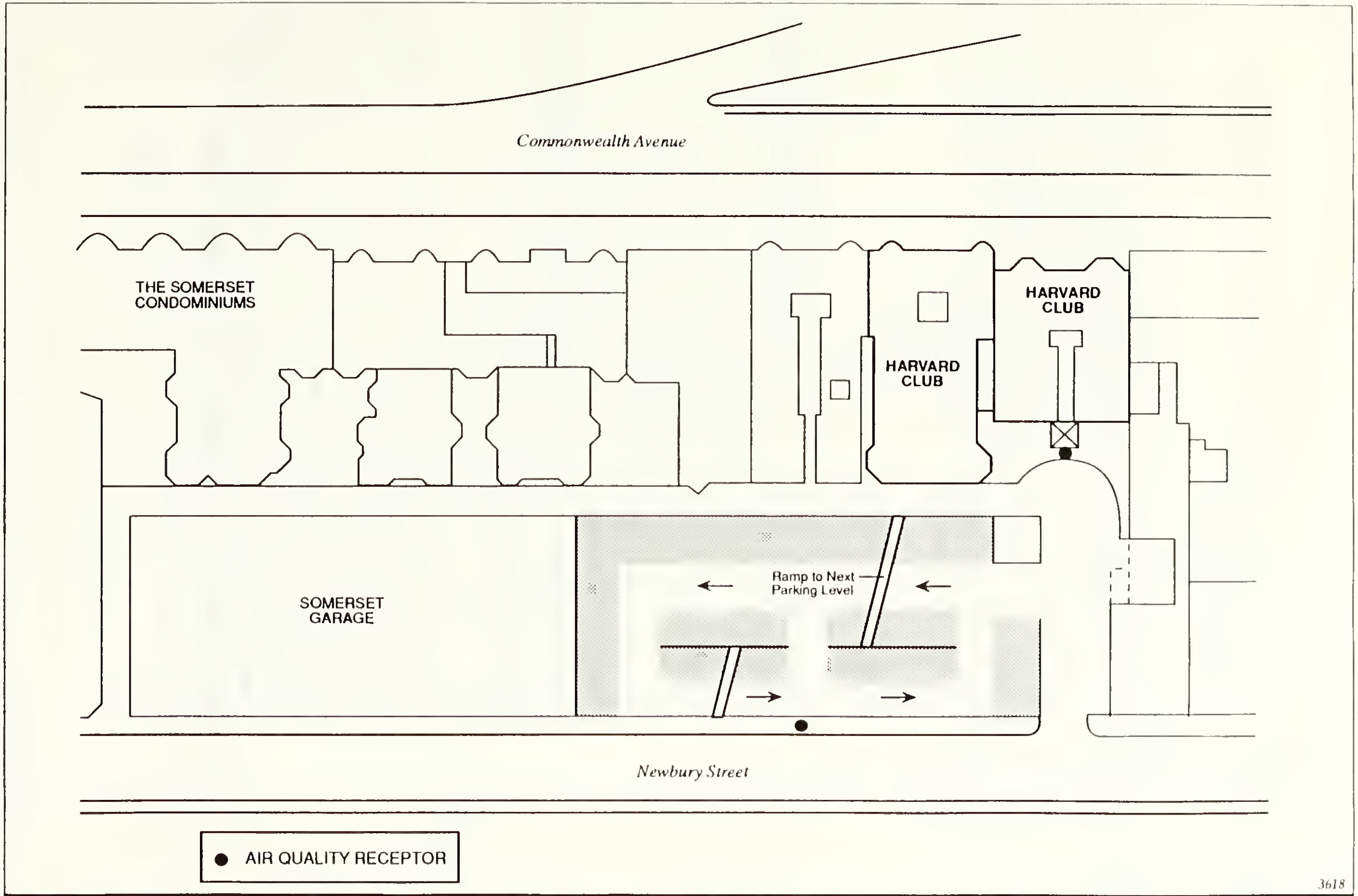

Figure IV-4
Harvard Club Garage
Air Quality Receptor Locations

1.4 Results

1.4.1 Intersection Analysis

The maximum predicted one-hour and eight-hour CO concentrations at sensitive receptors at the three analyzed intersections are presented in Table IV-1. The values represent the highest potential concentrations that might exist during the simultaneous occurrence of worst case meteorology and peak traffic conditions. Typical pollution levels are expected to be lower than these worst case values. The results of this study indicate that exceedances which currently exist will decrease in the future years, and that new exceedance conditions do not result from the project.

- Massachusetts Avenue/Newbury Street

  The air quality analysis at this intersection demonstrated no exceedance of one-hour CO National Ambient Air Quality Standards (NAAQS) for any case. The maximum existing one-hour level of 17.5 ppm was predicted at the T-Stop receptor on the southeast side of the intersection. This level is well below the 35 ppm air quality standard. Under future cases, one-hour levels decrease as a result of emission reductions for the motor vehicle fleet. The maximum predicted one-hour level in the Build case is 14.8 ppm, occurring at the Sleep-a-Rama receptor, located on the northwest side of the intersection. This is only a 0.2 ppm increase over the No-Build case and is also well below the 35 ppm air quality standard.

  Under the existing case, two receptors demonstrate an exceedance of the eight-hour NAAQS of 9.0 ppm at the Massachusetts Avenue/Newbury Street intersection. The Sleep-a-Rama receptor and T-Stop receptor had exceedances of 0.1 and 0.5 ppm over the ambient standard, respectively. There are no exceedances of NAAQS predicted under the future cases. The maximum predicted level is 8.2 ppm, at the T-Stop receptor under the Build case. This is a 0.1 ppm increase above the No-Build level.

TABLE IV-1
INTERSECTION ANALYSIS: MAXIMUM PREDICTED CO IMPACTS (PPM)

Intersection	Receptor	Existing		1994 No-Build		1994 Build	
		1-Hr	8-Hr	1-Hr	8-Hr	1-Hr	8-Hr
Massachusetts Avenue/ Newbury Street	Urban Outfitters	16.0	8.8	13.7	7.6	13.9	7.6
	Tower Records	15.8	8.7	13.6	7.5	13.6	7.5
	Sleep-a-Rama	17.3	9.1	14.6	7.8	14.8	7.9
	T-Stop	17.5	9.5	14.7	8.1	14.7	8.2
	Bus Stop	16.0	8.6	13.8	7.5	13.9	7.5
Massachusetts Avenue/ Commonwealth Avenue	White Hen Pantry	16.4	8.5	13.6	7.3	13.6	7.3
	Sage's	14.4	7.6	11.8	6.6	12.0	6.6
	Emerson College	22.7	12.0	18.5	9.6	18.6	9.6
	Telephones	15.6	8.3	13.4	7.0	13.8	7.2
	The Eliot	23.8	12.8	19.1	10.6	19.2	10.6
	Coolidge Cleaners	14.6	7.7	12.3	6.7	12.7	6.9
Commonwealth Avenue/ Charlesgate East	Park Steps North	12.9	6.9	11.1	6.1	11.5	6.3
	Park Steps South	19.0	11.2	15.6	9.0	15.5	9.0
	ELS Language Center	21.1	11.7	17.2	9.7	17.2	9.7
	Lief Erikson Statue	21.0	11.4	17.0	9.3	17.0	9.3
	418 Commonwealth	19.1	10.0	15.9	8.2	16.0	8.2

Notes: Background levels included: 5.0 ppm (1-hour) and 3.0 ppm (8-hour).

National Ambient Air Quality Standards (NAAQS): 35 ppm (1-hour) and 9.0 ppm (8-hour).

o Massachusetts Avenue/Commonwealth Avenue

The predicted maximum one-hour concentration at this intersection is 23.8 ppm, occurring at The Eliot receptor under the existing case. This level is below the NAAQS standard of 35 ppm. In the future cases, the maximum predicted concentration is 19.2 ppm at The Eliot receptor under the Build case. This level is a 0.1 ppm increase above the No-Build case.

The eight-hour period analysis demonstrates exceedances of the NAAQS of 9.0 ppm at the Emerson College receptor on the northeast corner of the intersection and The Eliot receptor on the southwest corner for all three cases analyzed. Under the existing case the maximum predicted concentration is 12.8 ppm at The Eliot receptor. This level is 3.8 ppm over the NAAQS. In the future No-Build and Build cases, the maximum predicted impact is 10.6 ppm, 1.6 ppm over the NAAQS. Results indicated that exceedances will be unaffected with construction of the project.

o Commonwealth Avenue/Charlesgate East

The air quality analysis at this intersection demonstrated no exceedance of the CO one-hour NAAQS for any case. The maximum predicted concentration is 21.1 ppm, occurring at the ELS Language Center receptor under the existing case. The maximum level for the future Build and No-Build cases is 17.2 ppm at the ELS Language Center receptor. The analysis demonstrates no impact of the project at this receptor.

Under the existing case, four of the five receptors at this intersection, demonstrate maximum predicted impacts exceeding the eight-hour NAAQS of 9.0 ppm. The maximum predicted level is 11.7 ppm occurring at the ELS Language Center receptor. This level decreases to 9.7 ppm for the two future cases; 0.7 ppm over the NAAQS. The levels do not increase as a result of the project and, therefore, the exceedances at the two receptors are the same in the Build and No-Build cases.

1.4.2 Garage Analysis

Table IV-2 presents the results of the air quality analysis for the proposed parking garage. Included in the analysis is traffic in the garage and on Newbury Street Extension. The maximum predicted one-hour concentration is 8.5 ppm, at the sidewalk receptor location. This level is well below the NAAQS of 35 ppm. The maximum predicted eight-hour concentration is 4.8 ppm, at the Harvard Club entrance receptor. This level is also well below the NAAQS of 9.0 ppm. Based on the analysis, it is anticipated that the air quality at the receptors chosen is representative of the overall air quality surrounding the garage.

1.5 Mitigation Measures

The Commonwealth's I&M program started on April 1, 1983 and has been assumed in the calculation of motor vehicle emission rates. This program, which results in the overall reduction of yearly motor vehicle emissions, was established to ensure compliance with the NAAQS on a statewide basis, as outlined in the Massachusetts State Implementation Plan. The attainment and maintenance of the NAAQS for CO in the future is dependent on the continued enforcement of this program.

Other traffic-related mitigation measures to reduce vehicle conflicts and delays could similarly improve existing and future air quality. In general, such traffic-related measures include roadway geometry changes which increase roadway capacities, and signal timing optimization which enhances traffic flow.

Currently, the City of Boston is in the process of optimizing, through computer operated traffic flow monitors, approximately 250 signals downtown, including the project study area. Completion of this program is expected this year. Computer driven signal timings, which will be based on demand, will improve traffic flow over peak one- and eight-hour periods in the project area. During eight-hour periods, when the only violations of the NAAQS for CO were predicted, continual monitoring of traffic conditions and appropriate adjustments to signal timings under this program could potentially provide significant air quality benefits. In addition, this program could serve to reduce CO background levels as general flow in the downtown area should improve.

TABLE IV-2
GARAGE ANALYSIS: MAXIMUM PREDICTED CO IMPACTS (PPM)

Receptor	1-Hour	8-Hour
Harvard Club Entrance	8.2	4.8
Newbury Sidewalk	8.5	4.5

Note: Background levels include: 5.0 ppm (1-hour) and 3.0 ppm (8-hour).
National Ambient Air Quality Standards (NAAQS): 35 ppm (1-hour) and 9.0 ppm (8-hour).

1.6 Regional Impacts

The project's effect on regional ozone was qualitatively examined. Boston, as well as most of the Northeast, is considered non-attainment for ozone. Motor vehicles emit non-methane hydrocarbons (NMHC) and nitrogen oxides (NO_x), both precursor pollutants of tropospheric ozone.

Currently there are no approved models to determine how ozone levels will be modified relative to changes in traffic patterns. In addition, ozone is a regional pollutant. It and its precursors can be transported on a regional scale. It is impossible to determine if, on a larger scale, any one project would increase, decrease, or effect ozone concentrations at all.

The proposed parking garage will be constructed to meet the parking needs of already existing traffic to the Harvard Club. Additional parking will be available to serve additional parking demand in the area. Because of difficulties in finding parking in the project area, the proposed parking garage is not anticipated to increase vehicle miles traveled (VMTs) and has the potential to reduce VMTs in the immediate area by reducing the need for traffic to circle the area in an attempt to find available parking. Therefore, the proposed parking garage is expected to have a minimal and potentially positive impact on ozone.

1.7 Construction Related Impacts

Project related air quality impacts are anticipated to be limited to emissions of fugitive dust during the construction period. Impacts associated with land clearing, ground excavation, cut-and-fill operations and other construction activities may generate fugitive dust, which will result in localized increases in airborne particulate levels. Fugitive dust emissions from construction activities will depend on such factors as the properties of the emitting surfaces (e.g., soil silt content, moisture content, and volume of spoils), meteorological variables, and construction practices employed.

To reduce emissions of fugitive dust and minimize impacts on the local environment, a number of strictly enforced mitigation measures will be adhered to. These include:

- Use of covered trucks.
- Minimizing storage of spoils on the construction site.
- Monitoring of actual construction practices to ensure that unnecessary transfers and mechanical disturbances of loose materials are minimized.

1.8 Summary

The air quality analysis for the proposed Harvard Club Garage project demonstrated no new or increased exceedances of the NAAQS for CO at any location. Of the three intersections in the study area, two - Massachusetts Avenue/Commonwealth Avenue and Commonwealth Avenue/Charlesgate East - have predicted maximum levels in exceedance of the eight-hour NAAQS for CO in both the Build and No-Build cases. At both intersections, however, the analysis demonstrates that the exceedances are the same with or without the proposed project showing that the project has no impact on air quality. All maximum concentrations in the 1994 study year are predicted to be lower than the existing year due to improvements in emissions from the overall vehicle fleet.

As the analysis reflecting the proposed project with 430 spaces showed no impact on air quality, a smaller scale alternative would also show no impact on air quality.

2.0 SOLID WASTES

The proposed Harvard Club Garage project does not require any demolition and therefore, solid waste during construction is expected to be limited to that from tearing up existing pavement. In addition, because the proposed project is solely a garage, operational waste generated by the project or a lesser scale alternative is also expected to be minimal.

2.1 Construction Waste

The existing lot has an asphalt surface which will be excavated and contained on-site. No more than 15,000 cubic yards will be excavated and removed daily. After the excavation is completed, the asphalt will be processed with new materials to obtain a suitable backfill or subgrade material to be used on-site. The remainder will be disposed of in accordance with the Commonwealth of Massachusetts solid fill requirements.

Any construction debris will be disposed of throughout the construction period. The contractor will assume full responsibility for disposing the debris efficiently and appropriately in accordance with applicable regulations.

2.2 Operational Waste

Upon completion of construction, solid waste generated by the proposed Harvard Club Garage project will increase only slightly as a result of the project. As a garage only, the project does not generate much operational solid waste. Any waste generated by the operation of the proposed Harvard Club Garage will be removed from the loading areas with the trash generated by the Harvard Club by independent contractors.

3.0 NOISE

The Noise study included a two-part analysis undertaken to determine the potential noise impacts of the proposed project. Step one consisted of a noise survey of the existing environment to determine existing noise levels and to determine the dominant noise sources. The second step consisted of predicting and analyzing the post-development noise environment, including potential long-term noise impacts of project-generated traffic.

3.1 Noise Survey

3.1.1 Introduction

Noise level refers to the degree of pressure variations in the air to which the ear is sensitive. In assessing potential noise impacts, both the time fluctuations of the noise level and the maximum noise levels are important. The noise environment of a typical urban area is generally defined by a steady "background" noise, upon which is superimposed the noise of individual sources, such as passing vehicles, aircraft, or construction equipment. Noise fluctuations are often described by determining those levels exceeded a certain percentage of time.

Standard measurements used to characterize noise levels are:

L_{90}	The level exceeded 90 percent of the time, commonly used to describe the residual, or "background" noise level, below which ambient noise levels rarely fall.
L_{50}	The level exceeded 50 percent of the time, commonly used to describe the "average" ambient noise sound level.
L_{10}	The level exceeded 10 percent of the time, often used to describe the "near peak", common maximum, or "intrusive" sound levels, such as noise caused by vehicle passbys.
L_{eq}	Equivalent continuous sound. The steady dBA level which would produce the same A-weighted sound energy, over a stated period of time, as a time-varying sound source.

In discussing noise levels, the A-weighted decibel (dBA) was used for this study. A-weighting refers to a standard frequency weighting which approximates human hearing response. For example, people are more sensitive to high frequencies than low ones, so often a low frequency sound will be perceived to be softer than its pressure-equivalent at higher frequencies. A-weighting thus provides a good correlation of noise levels to a person's physiological response to noise exposure. Also, noise level is not measured or perceived on a linear, but on a logarithmic, scale. For example, if two equal sources are added together, the result is not a doubling of noise level, but an increase of 3 dBA in noise level.

3.1.2 Methodology

A noise monitoring program was conducted on July 11, 1990 at three receptor locations on or near the project site at four time periods. The monitoring locations were chosen at the existing parking lot entrance, entrance to the proposed garage, and at the west end of the site. Measurements were made at the AM peak (8:00 AM - 9:00 AM), midday (11:30 AM - 1:30 PM), PM peak (4:30 PM - 6:00 PM), and peak garage use (7:00 PM - 8:00 PM). One additional measurement was made at a fourth location behind the existing Somerset Garage during the AM peak to evaluate the effect of the operation of the garage and garage structure on noise propagation to buildings along Commonwealth Avenue.

Figure IV-5 shows the receptor locations.

3.1.3 Existing Noise Levels

Table IV-3 lists the results of the noise survey. The data from the noise survey indicates that noise levels along Newbury Street are fairly consistent throughout the day. Background levels at receptors adjacent to the street range from the upper 60's to low 70's. At receptor 2 (the proposed entrance), the background levels were consistently lower, ranging in the low to mid 60's. The highest noise levels were measured during the morning rush hour and the lowest noise levels during the evening, the time of peak use of the Harvard Club parking lot.

The most prominent noise source was traffic on the Massachusetts Turnpike. There was a steady flow of traffic on the Turnpike of cars, medium trucks, and many heavy trucks. Two other sources of noise which intermittently affected noise

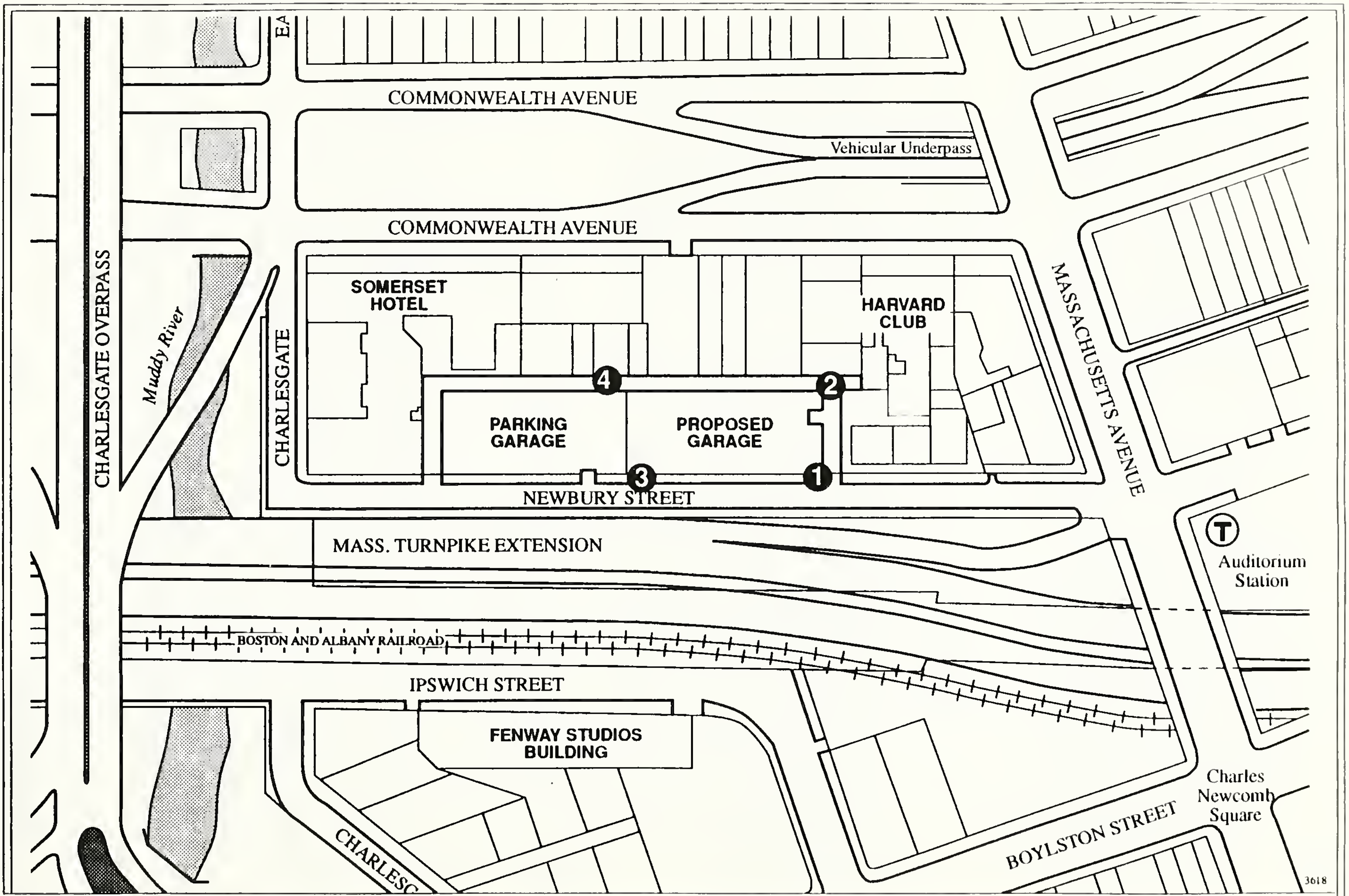

Figure IV-5
Noise Receptor Locations

TABLE IV-3

EXISTING NOISE LEVELS (dBA) MONITORED

Receptor Location	L_{90}	L_{50}	L_{10}	L_{eq}	Remarks
			7:30 AM - 9:00 AM (AM Peak Traffic)		
1	69	71	74	72	Commuter train passby.
2	66	67	69	68	Two jets and helicopter passby.
3	72	74	77	75	
4	70	72	74	72	
			11:30 AM - 1:30 PM (Midday)		
1	67	70	72	70	Seven jet passbys.
2	63	66	68	66	Four jet passbys.
3	71	74	77	74	Three jet passbys.
			4:30 PM - 6:00 PM (PM Peak Traffic)		
1	68	70	72	70	Commuter train.
2	66	67	70	68	
3	71	73	75	73	Commuter train.
			7:00 PM - 8:00 PM (Peak Garage Use)		
1	66	68	70	69	
2	62	64	66	64	
3	69	71	73	71	

levels at the project site were jets flying overhead and commuter trains from the railroad track on the opposite side of the Turnpike. Traffic noise from Newbury Street was intermittent, almost exclusively from cars and almost always overpowered by noise from the Turnpike.

The existing measurements also show that noise levels are higher on the west side of the study area (receptor 4 behind the Somerset Garage) than on the east side (receptor 2). This is likely due to the alignment of the Massachusetts Turnpike which acts as a noise barrier for the east side of the site.

3.2 Potential Impacts

To quantify the potential noise effects resulting from increased garage traffic on Newbury Street, an assessment was conducted using the Stamina 2.0 Noise Model.* By inputting the coordinates of Newbury Street and the noise receptor locations, existing hourly traffic volumes and speeds, the model can determine the contribution of traffic on Newbury Street to noise levels at each receptor location. By comparing these levels to the actual measured noise level, the extent to which traffic along Newbury Street contributes to the overall noise level can be determined at each receptor location. The results are shown in Table IV-4. The analysis indicated that Newbury Street is only a minor contributor to noise levels in the project area. Noise from the Turnpike clearly dominates the existing noise environment.

Since the noise levels of varying sources are added logarithmically to determine the overall noise level from all sources combined, it is clear that the noise level contribution of traffic on Newbury Street to the overall noise level of the area is minor. For example, at receptor 1, during the AM peak hour, traffic noise levels from Newbury Street are 54 dBA, based on the model results. However, the overall noise level measured is 72 dBA, 18 dBA higher than Newbury Street alone.

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* Stamina 2.0/BCR. Federal Highway Administration, Version 3, Traffic Noise Prediction Model. March 1983.

TABLE IV-4
NEWBURY STREET VS. OVERALL NOISE LEVELS

Peak Hour L_{eq} (dBA)*

	AM		PM	
Receptor	Newbury Street Modeled Noise Level	Measured Noise Level	Newbury Street Modeled Noise Level	Measured Noise Level
1	54	72	55	70
2	47	68	47	68
3	53	75	53	73

This means that noise levels from all other noise sources combined (without Newbury Street traffic) are 72 dBA already, since

$$\text{Log}\,(10^{54} + 10^{72}) = 72\ \text{dBA}$$

Given the proximity of the Massachusetts Turnpike and the number of other noise sources (airplanes, commuter trains, etc.) it is evident that noise from Newbury Street traffic plays a minor role in the overall noise environment of the area. This is also evidenced by the fact that noise levels measured between 7:00 and 8:00 PM were the lowest, even though this is the time of peak garage use.

3.2.1 Vehicular Noise

Based on the projected future No-Build and Build traffic volumes, an estimate of the noise contribution of traffic on Newbury Street at each receptor location was made for the future conditions. Table IV-5 lists the increases in sound pressure level contribution from additional traffic on Newbury Street likely at each receptor location for both future cases. Table IV-5 shows that Noise levels from traffic on Newbury Street will increase a maximum of 2 dBA (during AM peak hour), based on the projected Build traffic volumes. This increase in noise from Newbury Street will still have no effect on the overall noise levels at each receptor. For example, at Receptor 1, traffic noise from Newbury Street would need to increase by at least 10 dBA (64 dBA) before the overall noise levels begin to increase, since

$$\text{Log}\,(10^{64} + 10^{72}) = 72.5\ \text{dBA}$$

In addition, noise level changes generally begin to be perceptible to the human ear with increases of 3 dBA or more.

Even with the conservative assumption that the sound energy from traffic on the Massachusetts Turnpike remains at its present level, Newbury Street remains a minor source of noise to the project area for both the No-Build and Build cases.

TABLE IV-5
PROJECTED NOISE LEVEL INCREASES AT MEASUREMENT LOCATIONS FROM NEWBURY STREET TRAFFIC VOLUME INCREASES

	Traffic Volumes		
Peak Hour	Existing Volume	No-Build	dBA Increase
AM	133	142	less than 1
PM	149	166	less than 1

Peak Hour	No-Build	Build	dBA Increase
AM	142	206	2
PM	166	179	less than 1

3.2.2 New Garage Noise

It is evident from the existing measurements at locations 3 and 4 that the existing Somerset Garage has a minor effect on noise levels. Receptor 4 is approximately twice the distance from the turnpike, the primary source of noise. With this doubling of distance, a drop of 3dBA would be expected due to the greater distance the noise has to travel from source to receiver. The measured L_{eq} was, in fact, 3 dBA lower at receptor 4 than receptor 3. This indicates that the operation of the garage is a minor source of noise compared to the traffic on the Massachusetts Turnpike. Since the proposed Harvard Garage will be similar in size to the Somerset Garage it is safe to assume that the noise contribution of this new garage will be minor in comparison to the turnpike noise. No noticeable change in noise levels is expected since the noise from the turnpike will continue to dominate the noise environment.

4.0 WATER QUALITY AND RESOURCES

4.1 Introduction

The Water Quality and Resources section includes a description of the proximity of the proposed Harvard Club Garage site to the Muddy River and a description of storm drainage.

4.2 Proximity to the Muddy River

The proposed Harvard Club Garage is located on Newbury Street between Massachusetts Avenue and Charlesgate East. Review of the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) indicates that the proposed project site is outside of the 100-year floodplain. In addition, the Muddy River and its associated wetland resources of bank, land under a waterway, and bordering vegetated wetlands are more than 400 feet away from the site as shown on Figure IV-6. The Harvard Club Garage site is located outside the 100-foot discretionary buffer zone associated with any wetland resources.

4.3 Site Drainage

The site of the proposed Harvard Club Garage is served by separate sanitary sewer and storm drain systems. These systems, owned and operated by the Boston Water and Sewer Commission (BWSC), convey sanitary sewage to the Deer Island Wastewater Treatment Plant and storm drainage to the Charles River. There is presently no stormwater discharge from the project site to the Muddy River and there will also be no discharge to the Muddy River after development. The proposed Harvard Club Garage is not anticipated to impact water quality of the Muddy River.

Stormwater flows from the project site are not anticipated to change appreciably as a result of the development of the garage. The site is presently impervious and will continue to be so after development. Much of the post-development site runoff will consist of roof runoff which is typically considered "clean" compared to the existing parking lot runoff which may potentially contain salt, oil and grease, and other urban contaminants. In order to protect water quality, stormwater resulting from automobile snow-melt, etc. within the garage will be discharged to the storm drain system after passing through an oil/water

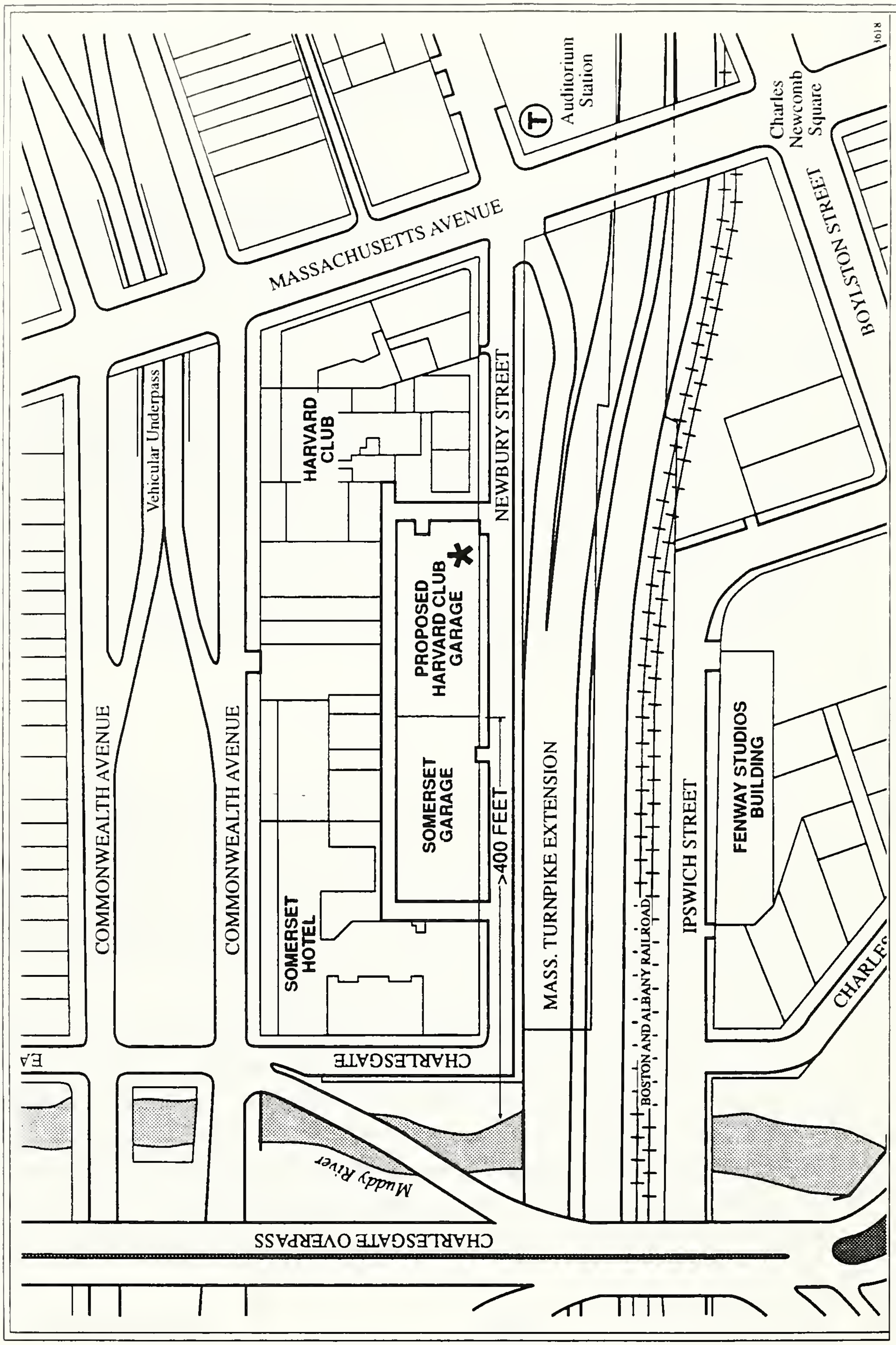

Figure IV-6
Distance From Muddy River

separator. The separator will prevent oil and gasoline from entering the storm drain system and will be inspected and maintained on a regular basis. More detailed information concerning wastewater disposal is included in Chapter VII, the Infrastructure Systems Component.

Site drainage and impacts on water quality would be the same for the proposed project as for a smaller scale alternative.

5.0 HAZARDOUS WASTE / GEOTECHNICAL

5.1 Introduction

Following initial approval of the proposed Harvard Club Garage, the Harvard Club will begin the necessary geotechnical work required for the project. A subsurface analysis will be conducted prior to the Construction Management Plan (CMP) and issuance of a building permit. The subsurface investigation will determine the possibility of contaminated soil and groundwater. If any exists, it will be removed in accordance with applicable regulations.

The analysis will also aid in determining the appropriate foundation construction methodology to minimize ground movement and settlement during excavation, and any potential impact on adjacent buildings. The CMP will include a description of the proposed groundwater monitoring and foundation and excavation construction methodologies.

5.2 Construction Methodologies and Possible Groundwater Monitoring and Mitigation

Throughout the ongoing design process, the project architects, contractors, and engineers will work together to determine a suitable foundation construction methodology that will minimize impacts on groundwater levels and adjacent buildings. Appropriate and specific monitoring measures, performance criteria, and potential for remedial measures will be determined and described as part of the Construction Management Plan to ensure that construction activities undertaken by the Harvard Club will not have an adverse impact on neighboring structures.

Initial studies have shown that the groundwater level is at +6 to +8 Boston City Base (BCB). The site has an elevation of approximately +22 and the levels below-grade are expected to extend 15 feet below to an elevation of +7 BCB. If below grade construction extends to the groundwater level, appropriate measures to monitor and minimize groundwater impacts will be proposed and described in the CMP.

In an effort to prevent and mitigate potentially adverse effects of groundwater level changes caused by below grade construction, several actions will be instituted. The Harvard Club will require contractors doing the excavation and below-grade construction to submit with their bid proposal a manual of operations. The manual will outline procedures to ensure that mitigation measures designated to minimize groundwater infiltration are enforced.

Results of the monitoring will be reported to the Harvard Club on a regular basis. In the event that construction activities appear to cause adverse hydrogeologic impulses, additional actions or mitigation measures necessary to minimize the adverse effects will be formulated by the construction contractor, developer and geotechnical engineer and implemented in a timely fashion.

5.3 Excavation

The proposed Harvard Club Garage includes 1½ levels of below-grade parking and, as described before, will require limited excavation of the site. The excavation will be completed with a three-yard back hoe. No more than 15,000 cubic yards will be excavated.

A portion of the material excavated will not be suitable for subsequent reuse on-site and will be disposed of off-site. The estimated 15,000 cubic yards of excavated material will be removed from the site and disposed of in accordance with the Commonwealth of Massachusetts solid fill requirements. The existing asphalt will be removed and processed with new materials to obtain a suitable backfill material to be used on-site.

6.0 CONSTRUCTION IMPACTS

6.1 Introduction

A Construction Management Plan will be approved by the Boston Transportation Department (BTD) prior to issuance of the building permit. The Plan will be in compliance with the BTD's Construction Management Plan and the DPIR. The designated contractor will be bound by the agreement.

The Construction Impacts section includes the proposed construction procedures, the anticipated construction impacts, and mitigation measures to minimize the impacts on the adjacent neighborhood residences and businesses. Construction impacts for a smaller scale alternative would be the same as for the proposed project.

6.2 Construction Activity Schedule

The construction period for the proposed Harvard Club Garage project is expected to last approximately eight months beginning in the second quarter of 1991 with expected completion in the first quarter of 1992. Typical construction hours for the project will be from 7:00 AM to 3:30 PM, Monday through Friday and occasionally on Saturday. A preliminary construction schedule is shown on Figure IV-7. The following sections include a plan for perimeter protection and pedestrian access to allow pedestrian activity and traffic movement during construction.

6.3 Construction Staging

In determining scheduling, truck routes, and staging locations for the proposed Harvard Club Garage project, particular attention will be given to ensure the protection of nearby residential and commercial streets. Each stage of construction will have minor truck and pedestrian traffic impacts since the proposed garage is located on Newbury Street where there is little pedestrian and automobile activity.

The proposed staging plan is designed to isolate the construction while providing safe access for pedestrians and automobiles during normal day to day activity and emergencies. A detailed construction plan will be included in the Traffic Maintenance Plan in compliance with the City's Construction Management Program as required by the

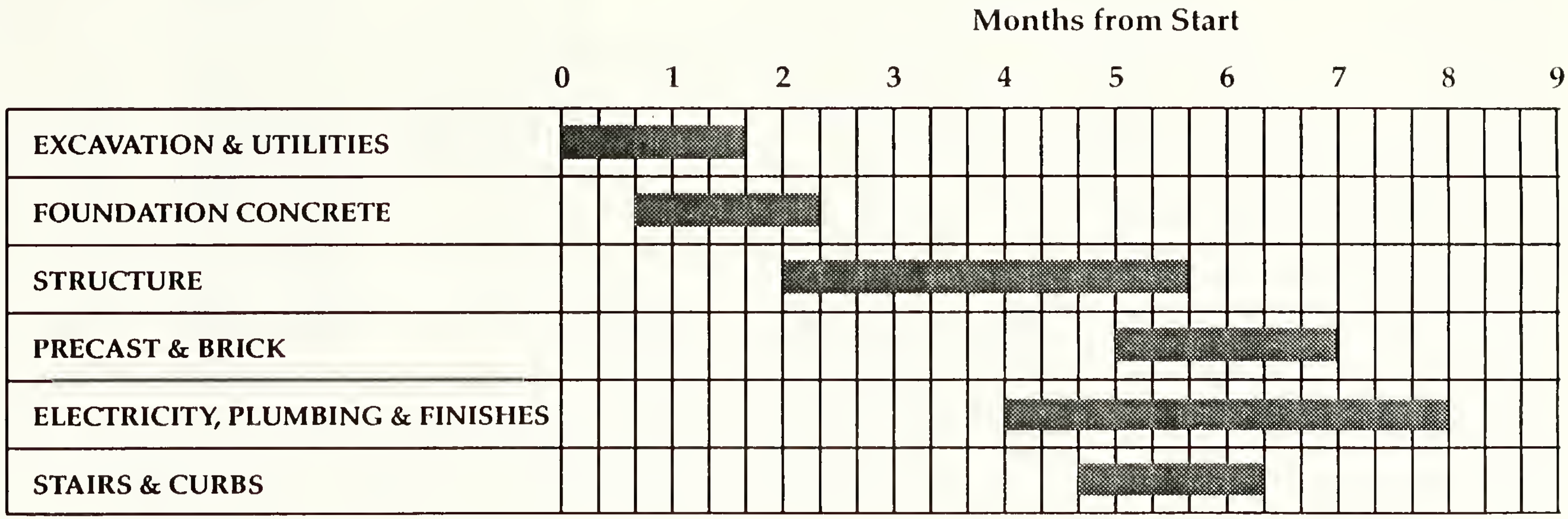

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Figure IV-7
Preliminary Construction Schedule

Boston Transportation Department (BTD) prior to construction. The following paragraphs include a description of the proposed staging locations and provisions for delivery and storage of construction materials and equipment. Figure IV-8 illustrates the staging areas. This plan, however, may be revised after further discussion with the City.

Initial plans have been developed concerning:

- o Perimeter Protection;
- o Pedestrian Safety;
- o Construction Material Handling;
- o Traffic Rerouting; and
- o Maintaining Services to Adjacent Buildings.

Perimeter Protection/Pedestrian Safety

Chain link fencing with moveable sections will be provided around the staging area on the north side of Newbury Street immediately adjacent to the site. Existing on-street metered parking on both the north and south side will be temporarily eliminated to continue to allow the existing one way traffic. Pedestrian cross overs with appropriate signage, demarkation, and barricades will be provided at a sufficient distance east and west of the project site to ensure safety.

Construction Material Handling

Construction materials will be delivered by truck via Newbury Street Extension. Material trucks will follow the existing one way traffic pattern and exit onto Commonwealth Avenue eastbound to Massachusetts Avenue. Trucks on Massachusetts Avenue may leave the area by the Massachusetts Turnpike, Storrow Drive westbound or eastbound to the Central Artery.

According to the June 1989 Howard/Stein-Hudson Report, approximately 2,200 cars per day pass on the Newbury Street extension daily. Because of this light trtaffic, Newbury Street should not be greatly impacted by the construction truck traffic. In an effort to minimize construction impact, material deliveries will be scheduled to avoid peak periods for the adjacent Somerset Garage. The Transportation Component has an additional description of traffic impacts.

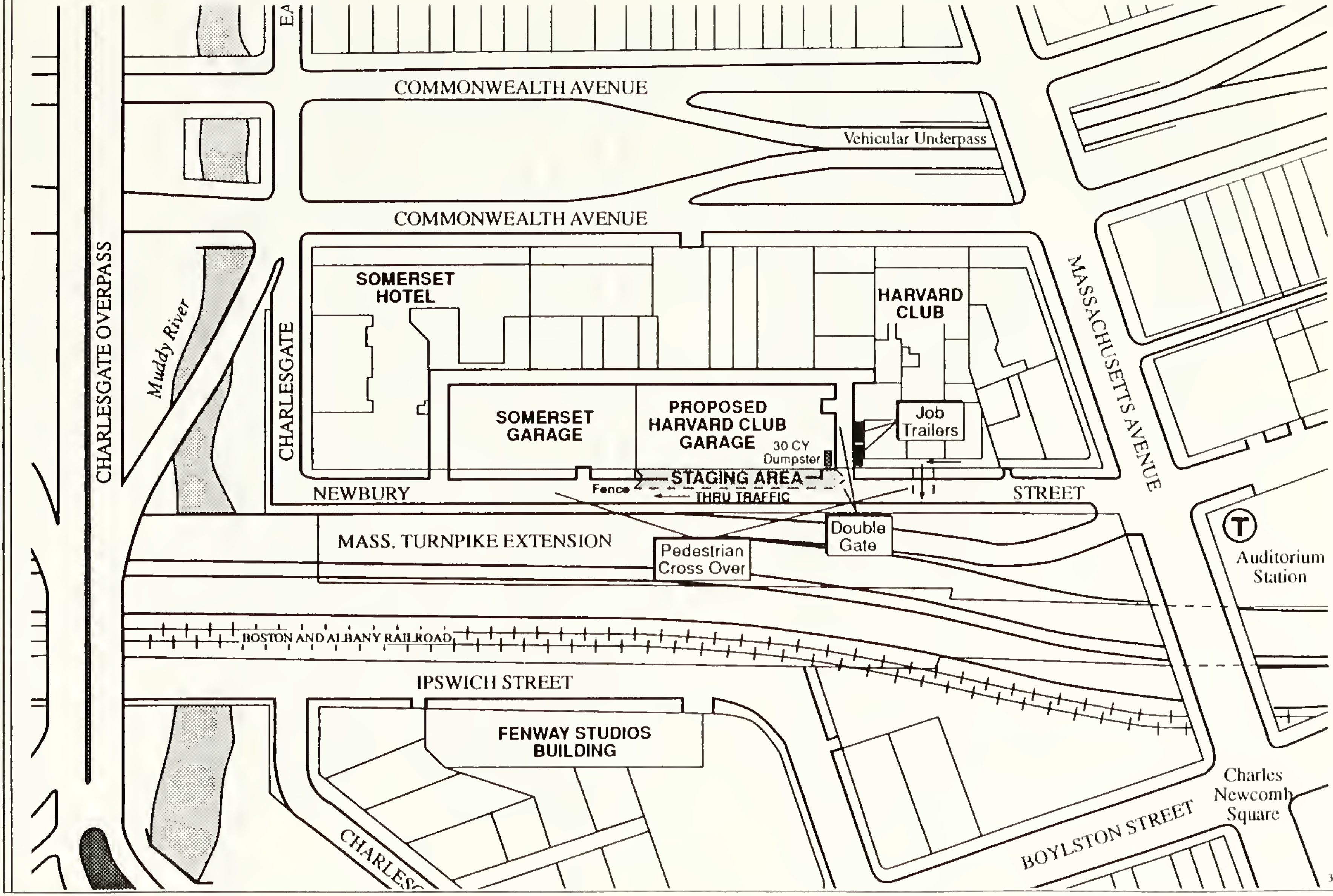

Figure IV-8
Construction Staging Plan

Traffic Rerouting

Traffic rerouting is not expected to be required during the construction of the proposed Harvard Club Garage. If any traffic rerouting is required, a detailed description will be included in the Traffic Maintenance Plan in compliance with the City's Construction Management Program.

Existing Alley

There is an existing alley running along the eastern boundary of the parking lot, the western edge of the adjacent Somerset Garage, and between the garages and the adjacent Commonwealth Avenue buildings. The alley is currently used to service Commonwealth Avenue buildings. The use of the alley will be maintained and all service vehicles will enter the alley to the west of the Somerset garage and move in a clockwise fashion. Existing pedestrian bridges between the Somerset garage and Commonwealth Avenue buildings prevent the use of this alley for construction operation or deliveries.

Parking

Because there will be only limited parking on-site during construction, the Harvard Club has obtained commitments from neaby garages to reserve existing surplus parking spaces for the Club and its visitors. The times of peak Club use are not the same as the peak use times for the nearby garages, and therefore, the garage expects to have surplus parking for the Club.

6.4 Public Safety

Access to the construction areas will be limited by perimeter controls, such as temporary construction fencing. Easily understandable signage will be provided to ensure safe pedestrian routing around and through the site.

6.5 Construction Employee Trip Generation and Worker Parking

As described in the Transportation Component, the number of construction workers will vary, but is estimated not to exceed 35 workers at one time. Trip generation for construction activities is a direct function of the number of construction workers. Assuming an auto occupancy of two persons per vehicle,* the 35 workers will generate 18 one-way trips. Due to the site's close proximity to the MBTA Green Line and bus routes, it can be expected that many of the construction workers will use public transportation, thereby further reducing the number of trips. In addition, construction workers generally travel before the peak hours (work day - 7:00 AM to 3:30 PM) and will not add to peak hour traffic volumes. As a result, no significant impacts to the study area roadway system are anticipated from construction worker vehicle traffic.

Construction workers will be encouraged to use public transportation. Ample secured storage for tools will be provided on-site so that workers will not need to transport their tools to and from the site on a daily basis. This will alleviate the need to drive to the site.

In order to discourage driving to the site, no on-site parking will be available for personal vehicles. Past experience shows that the lack of free or subsidized parking discourages use of personal vehicles and increases carpooling. For those who must drive, several parking garages exist within walking distance of the job site.

In addition, bulletin boards located around the site will be used to post bus schedules, train schedules, and car-pooling information. Efforts will be made to optimize construction workers' use of all available means of alternative transportation.

The peak demand for workers should occur during the second quarter of 1991. The remainder of the construction period will demand fewer workers at any one time. The relatively small number of vehicles that may be used during the construction period should be absorbed by the parking facilities near the site.

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* A relatively high auto occupancy rate is assumed due to the limited parking in the area, the cost of parking, and the increased inclination of construction workers to carpool.

6.6 Truck Routes and Volumes

As also described in the Transportation Component, trucks will be needed to remove material excavated from the site and to deliver construction materials to the site. The trucks removing excavated material and trucks delivering steel are anticipated to be eighteen wheel trucks. Truck traffic will vary throughout the construction period, depending on the activity. The volumes described below are estimates and may be refined as the construction schedule becomes finalized.

The largest anticipated number of construction trucks will be for the excavation and concrete operation. Approximately 20 trucks per day, every third day, will be used for the concrete operation. During excavation, there will also be approximately 20 trucks per day going to the site. The period of excavation requiring the 20 trucks per day will be completed prior to the concrete pouring also requiring 20 trucks per day. The excavation and concrete operation is expected to last approximately 2½ months, and should occur during the second quarter of 1991 through the third quarter of 1991. This volume is expected to decrease to 4 trucks per day beginning in the third quarter of 1991 and continue through completion.

The impacts caused by construction trucks during the evening peak hour are expected to be minimal because deliveries will be completed prior to the PM peak hour. Morning peak hour impacts are expected to be minor due to deliveries being spread uniformly during the work day. A maximum of 20 trucks per day at the Harvard Club Garage site translates to less than 3 trucks per hour if distributed uniformly over an eight-hour day.

Limiting the impacts of construction traffic and truck noise on the adjacent neighborhood and taking advantage of the site's close proximity to the Massachusetts Turnpike were the most important factors in determing the truck routes. Enforcement of truck routes will be accomplished through clauses in the contractors' and subcontractors' agreements. The proposed route is shown on Figure IV-9. Clauses in subcontractors agreements and the issuance of truck route maps are anticipated to eliminate construction truck travel through Kenmore Square and through residential Back Bay streets. The existing one way clockwise traffic pattern upon entering the Newbury Street extension returns the traffic to Massachusetts Avenue. From Massachusetts Avenue, the trucks can go north along Massachusetts Avenue into Cambridge, west onto the Massachusetts Turnpike via the on-ramp at Massachusetts Avenue and Newbury Street, east along Boylston Street into Boston, or south along Massachusetts Avenue to the Southeast

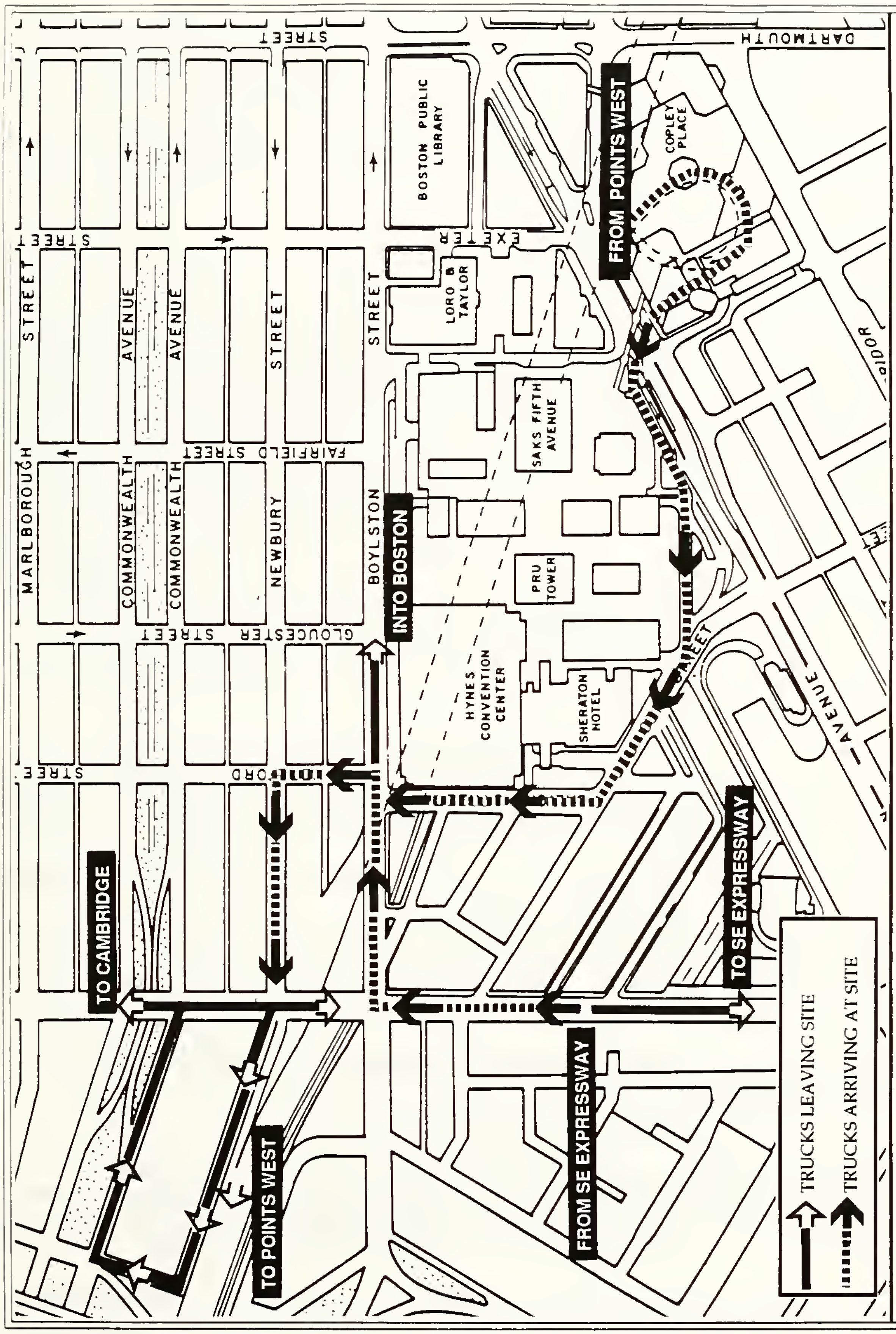

Figure IV-9
Truck Routes

Expressway. To arrive at the site, trucks may exit the Massachusetts Turnpike at the Prudential exit, travel along Belvidere to Dalton Streets, across Boylston Street to Hereford Street, and onto Newbury Street. From the Southeast Expressway, trucks will travel north along Massachusetts Avenue to east on Boylston Street, and north on Hereford Street to Newbury Street.

6.7 Construction Air Quality

As also described in Section 1.7 of the Environmental Protection Component, project-related air quality impacts are anticipated to be limited to emissions of fugitive dust during the demolition construction periods and are expected to be minimal. Pollution generated from construction-related traffic and construction machinery should be minor and not result in any adverse impact to air quality. Impacts associated with land clearing, ground excavation, cut-and-fill operations, and other construction activities may generate fugitive dust, which will result in localized increases in airborne particulate levels. Fugitive dust emissions from construction activities will depend on such factors as the properties of the emitting surfaces (e.g., soil silt content, moisture content, and volume of spoils), meteorological variables, and construction practices employed.

Mitigation

To reduce emissions of fugitive dust and minimize impacts on the local environment, a number of strictly enforced mitigation measures will be adhered to. These include:

- The use of wetting agents on areas of exposed soil on a scheduled basis or as required.
- Use of covered trucks for transportation of excavated material.
- Locating aggregate storage piles away from pedestrian activity.
- Minimizing storage of debris on-site.
- Monitoring of actual construction practices to ensure that unnecessary transfers and mechanical disturbances of loose materials are minimized.
- Periodic street and sidewalk cleaning to minimize dust accumulations.

6.8 Construction Noise Impacts

Construction activities will result in the creation of temporary noise and vibration, as a result of the operation of construction equipment on-site and traffic to and from the construction site. The project will also include concrete placement and pile-driving. Actual noise levels will depend on such factors as the location of the work and the choice of equipment used. The buildings abutting the proposed garage, including the Harvard Club, will serve to shield major pedestrian ways such as Commonwealth Avenue and the majority of the Back Bay residential area from the construction noise. The area that will be most impacted by the construction noise is the Newbury Street extension. However, due to the immediate proximity of the Massachusetts Turnpike, construction noise will be masked by high ambient noise levels from the Turnpike. Noise generated by construction truck traffic will be temporary and variable in nature and will also be largely masked by the Massachusetts Turnpike.

Mitigation

There are a number of measures which can be taken to mitigate noise at the Harvard Club Garage site, including:

- Using appropriate mufflers on all equipment.
- Installing enclosures around the work area where stationary equipment is being used.
- Replacing specific construction operations and techniques by less noisy ones - e.g., using welding instead of riveting and mixing concrete off-site instead of on-site.
- Selecting the quietest of alternate items of equipment - e.g., electric instead of diesel-powered equipment, hydraulic tools instead of pneumatic impact tools.
- Scheduling equipment operations to keep average levels low, to synchronize noisiest operations with times of highest ambient levels, and to maintain relatively uniform noise levels.

- Turning off idling equipment.
- Locating noisy equipment as far as possible from sensitive areas.

With the use of appropriate mitigative measures, a reduction in construction noise levels of 5 to 10 dBA can be achieved.

6.9 Foundation Construction Methodology

As described in Section 5.0, the foundation construction methodology has not yet been selected. Currently, the use of either spread footings or pressure injected footings (PIF's) are being considered. Test borings will be taken from the site to determine the presence and extent of ledge, subgrade material and water table.

Throughout the ongoing design process, the project architects, contractors, and engineers will work together to determine a suitable foundation construction methodology that will minimize impacts on groundwater levels and adjacent buildings. Appropriate and specific monitoring measures, performance criteria, and contingency plans for remedial measures will be determined and described as part of the Construction Management Plan to ensure that construction activities undertaken by the Harvard Club will not have an adverse impact on neighboring structures.

In an effort to prevent and mitigate potentially adverse effects of groundwater level changes caused by below-grade construction, several actions will be taken. The Harvard Club will require contractors doing the excavation and below-grade construction to submit with their bid proposal a manual of operations. The manual will outline procedures to ensure that mitigation measures designated to minimize groundwater infiltration are enforced.

Results of the monitoring will be reported to the Harvard Club on a regular basis. In the event that construction activities appear to cause adverse hydrogeologic impulses, additional actions or mitigation measures necessary to minimize the adverse effects will be formulated by the construction contractor, developer, and geotechnical engineer and implemented in a timely fashion.

6.10 Excavation

As described in Section 5.3, no more than 15,000 cubic yards of excavation will be completed with a three-yard backhoe. The portion of the material excavated not suitable for subsequent reuse on-site will be removed from the site and disposed of in accordance with the Commonwealth of Massachusetts solid fill requirements.

7.0 RODENT CONTROL

The City of Boston has declared that the infestation of rodents in the City is a serious problem. In order to control this infestation, the City has established requirements under the Massachusetts State Sanitary Code, Chapter II, 105 CMR 410.550 and the State Building Code, Section 108.6. Policy Number 87-4 establishes that extermination of rodents shall be required for issuance of permits for demolition, excavation, foundation, and basement rehabilitation.

Presently, the Harvard Club has an active pest control program for the Club. The program provides for weekly extermination of the interior and exterior of the current Harvard Club building and parking lot. Licensed and certified pest control operators carry out the weekly extermination. Upon completion of the proposed garage, the rodent control program will be updated and expanded to accommodate the proposed Harvard Club Garage. In addition, prior to any demolition or construction, the construction contractor will initiate a rodent control program.

A rodent extermination certificate will be filed with the building permit application to the City. Rodent inspection monitoring and treatment will be carried out before, during, and at the completion of all foundation work for the proposed project, in compliance with the City's requirements. Rodent extermination prior to work start-up will consist of treatment of areas throughout the project area, including alleyways, surrounding building exteriors, and building interiors. During the construction process, regular service visits will be made in order to maintain effective rodent control levels.

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V. Urban Design Component

V. URBAN DESIGN COMPONENT

1.0 INTRODUCTION

1.1 Location

The site of the proposed Harvard Club Garage is located on Newbury Street to the west of Massachusetts Avenue and to the north of the Massachusetts Turnpike. The site area is approximately 19,500 square feet and is presently vacant and operated as a surface parking lot with 105 spaces. The proposed garage is on the north side of Newbury Street between the existing Somerset Garage and the existing Squash Court Extension and is to the rear of the Harvard Club of Boston. Located within the Back Bay Historic District, the proposed project is near the Hotel Somerset and the puritan Hotel, and is across the Massachusetts Turnpike from the Fenway Studios building. The Fenway Studios building is on the "National Register of Historic Places". Access to the site is gained from the extension portion of Newbury Street, west of Massachusetts Avenue. Access to the garage is at the back of the site near the existing Harvard Club back door drive and turn-around. The back entry and turn-around have recently been redone and well-finished in granite and brick.

1.2 Existing Conditions

The architectural character of nearby structures may be established by reference to the accompanying locator key (Figure V-1) and photographs (Figures V-1A through V-1F). The locator key shows the views from the spots noted. To the west of the site is the existing Somerset Garage, a building with a layout which is the mirror image of the proposed project. While this mirror image is interesting in that it illustrates appropriate construction and layout for a similar program, the design unfortunately retains a stark appearance due to its unadorned concrete finish. West of the Somerset Garage is the simplified rear facade of the Hotel Somerset which extends to the corner of Charlesgate. To the east of the proposed garage is the existing Harvard Club back door drive and turn-around. Adjacent to and east of the drive is the plain brick enclosure of the Harvard Club Squash Courts and the service entrance of the commercial space fronting Massachusetts Avenue. The site is bounded to the east and north by the existing U-shaped mid-block alley. North of the alley is the rear of Windsor Place Commercial and

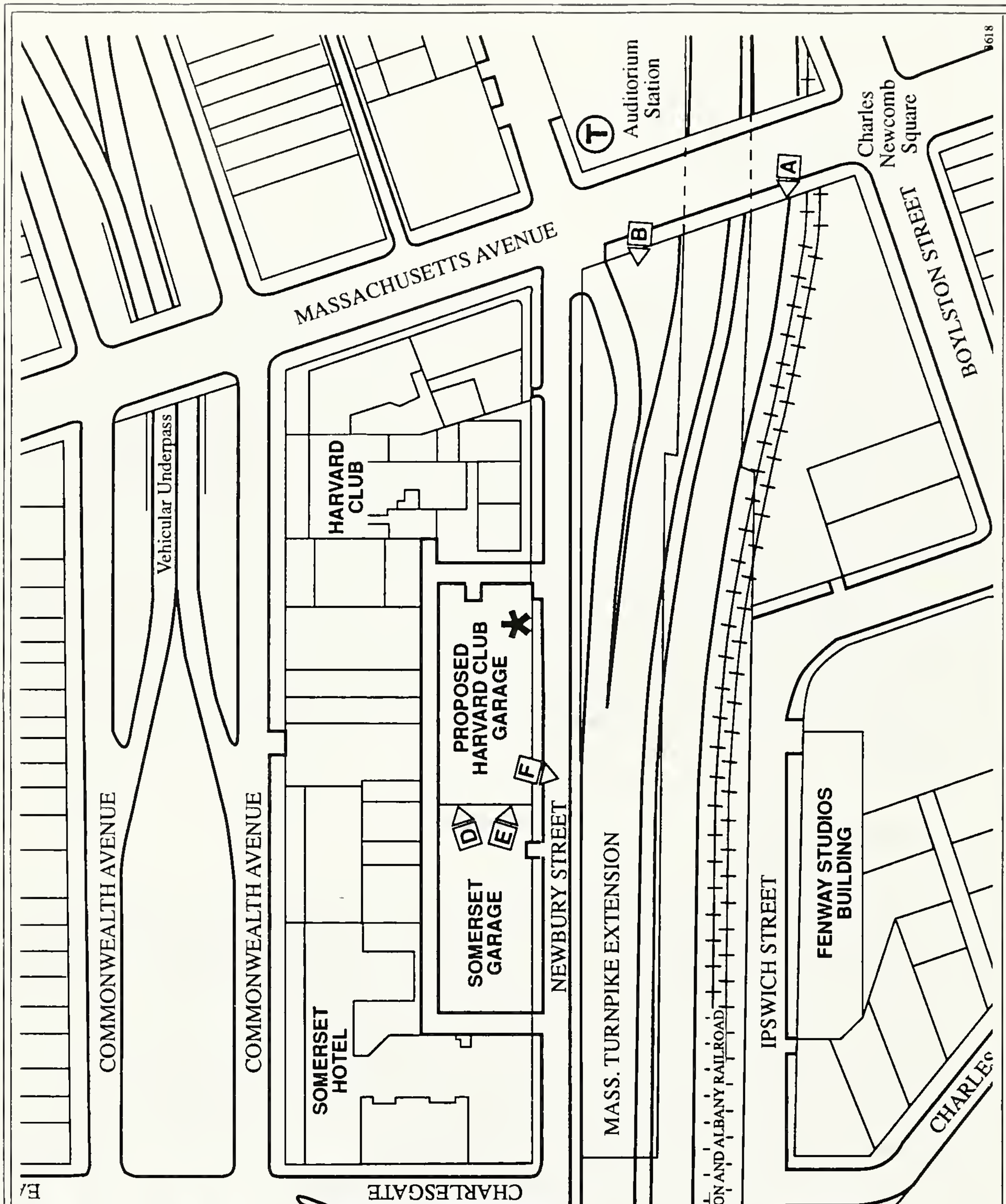

Figure V-1
Locator Key

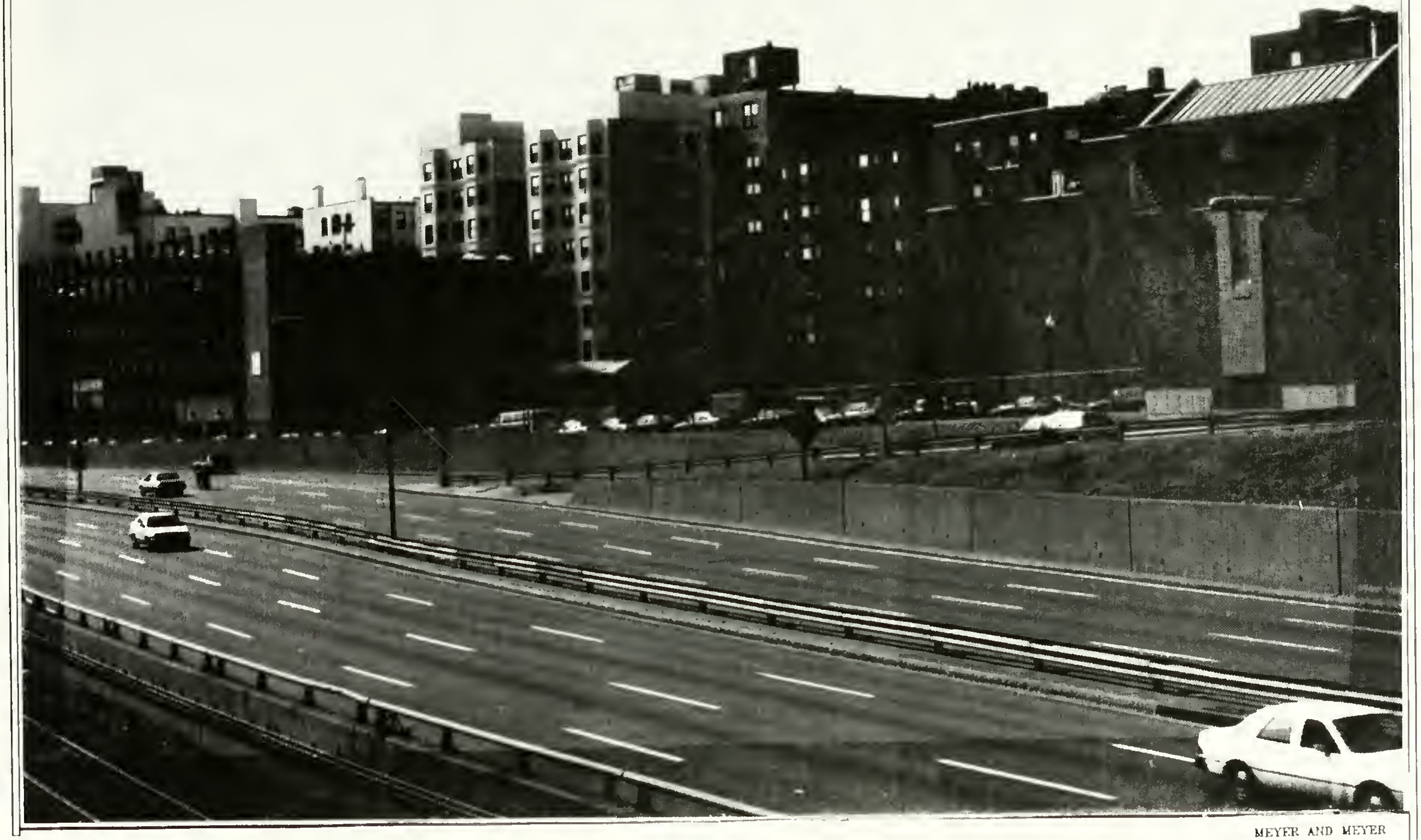

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Figure V-1A

View of Site from Railroad Track at Massachusetts Avenue

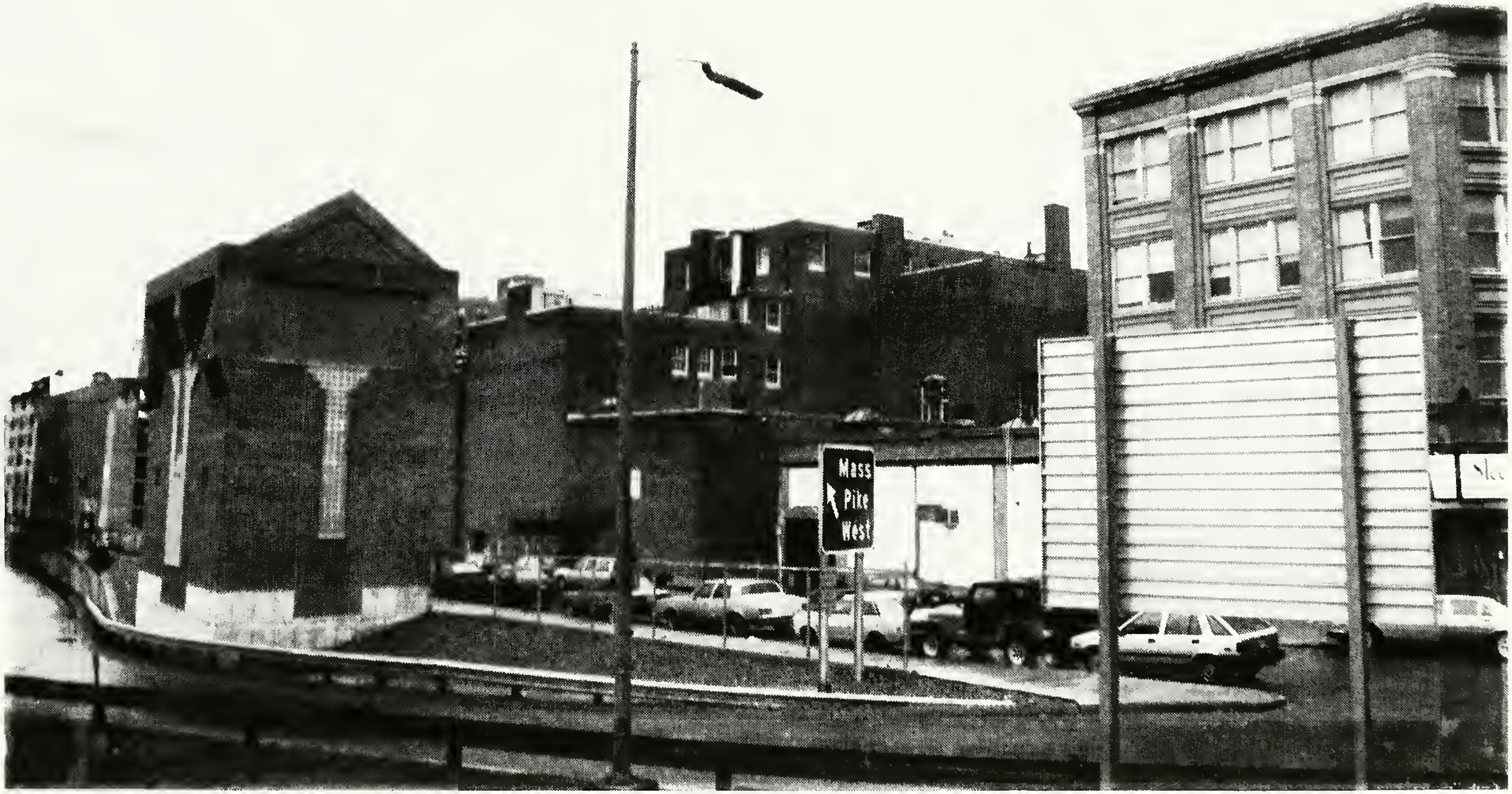

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Figure V-1B
View of Site From Massachusetts Avenue at Entrance Ramp to Massachusetts Turnpike

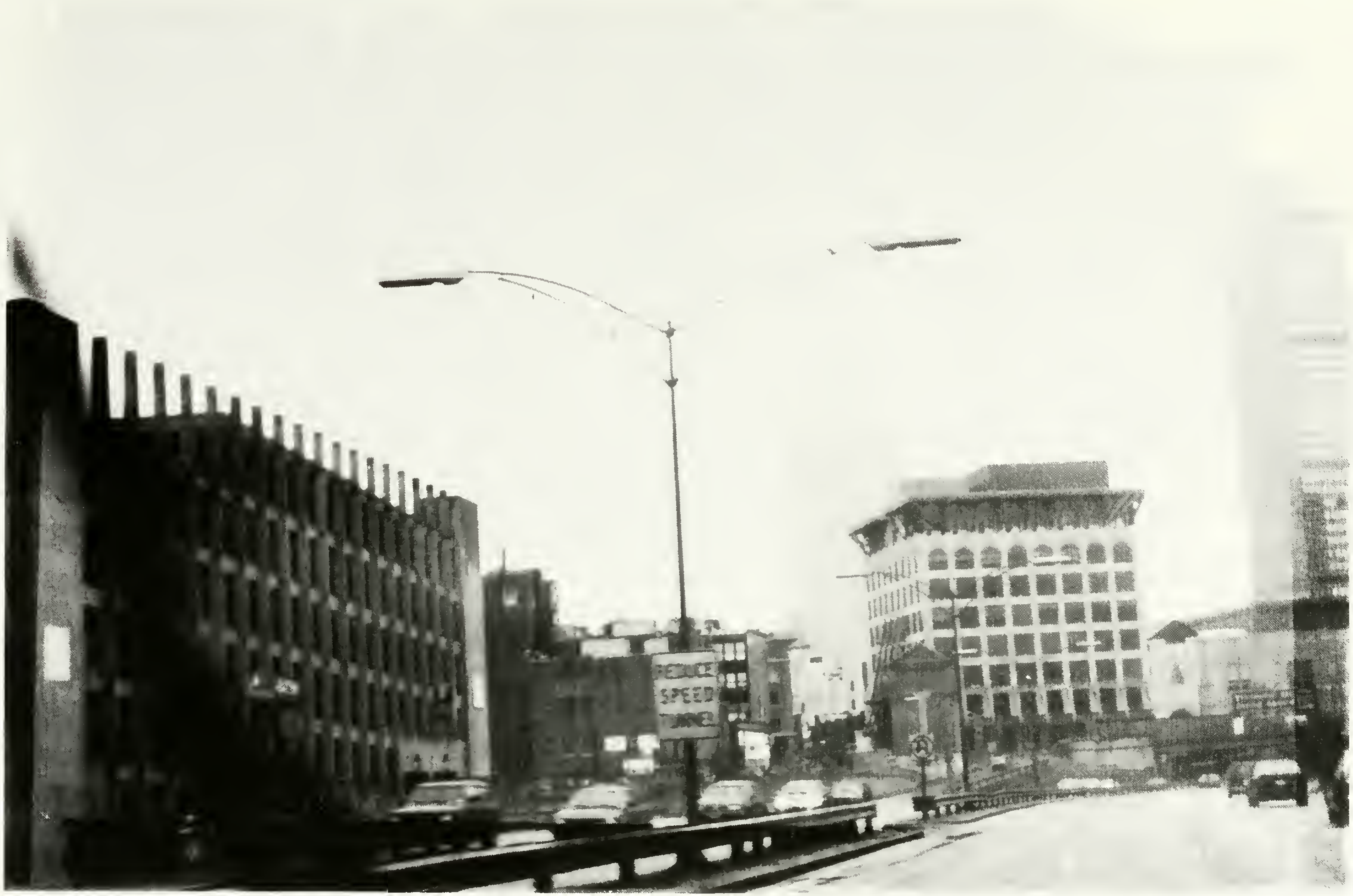

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Figure V-1C
View of Site From Charlesgate Overpass and Railroad

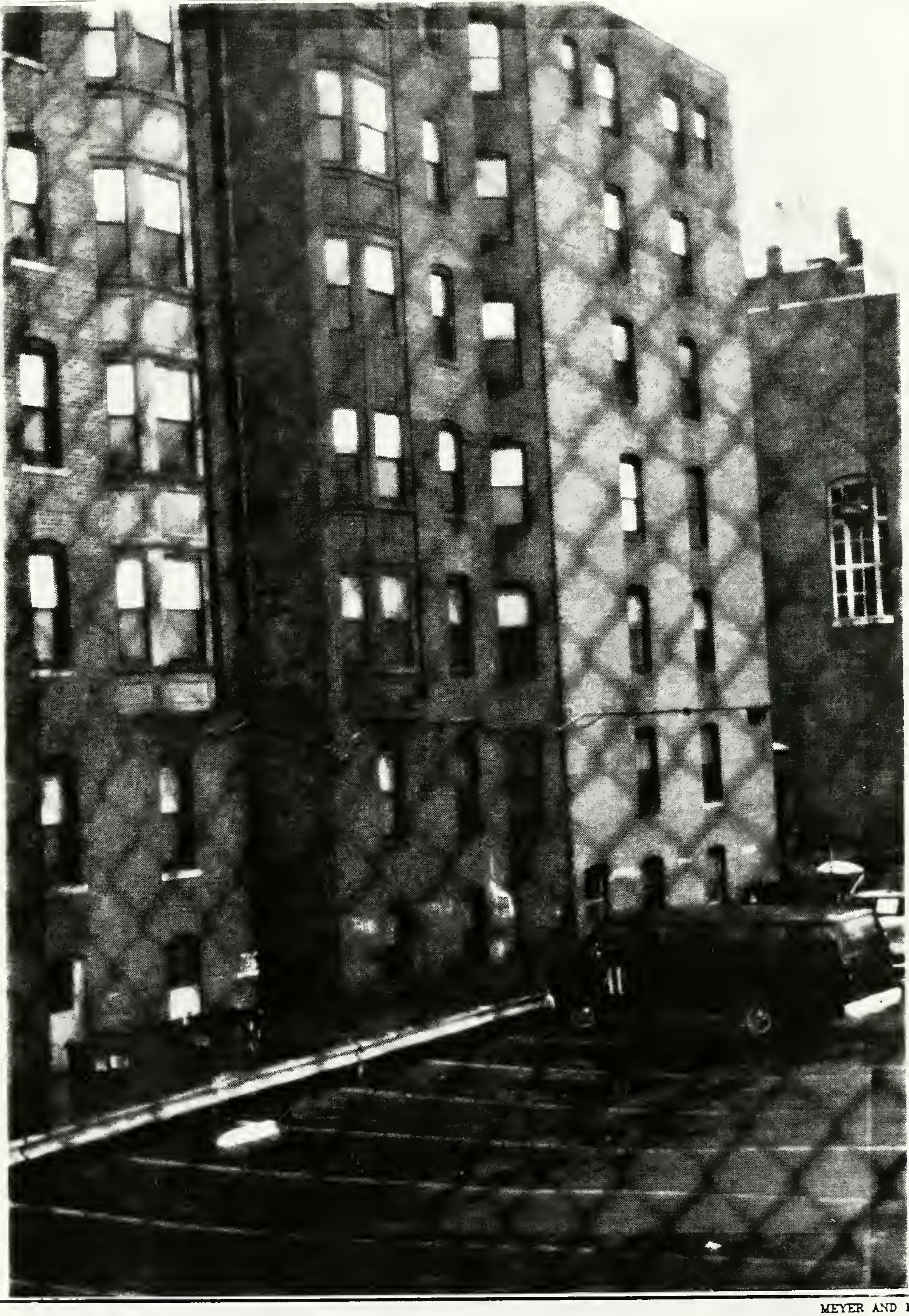

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Figure V-1D
View of Site and Back of Windsor Place From Western Boundary of Site

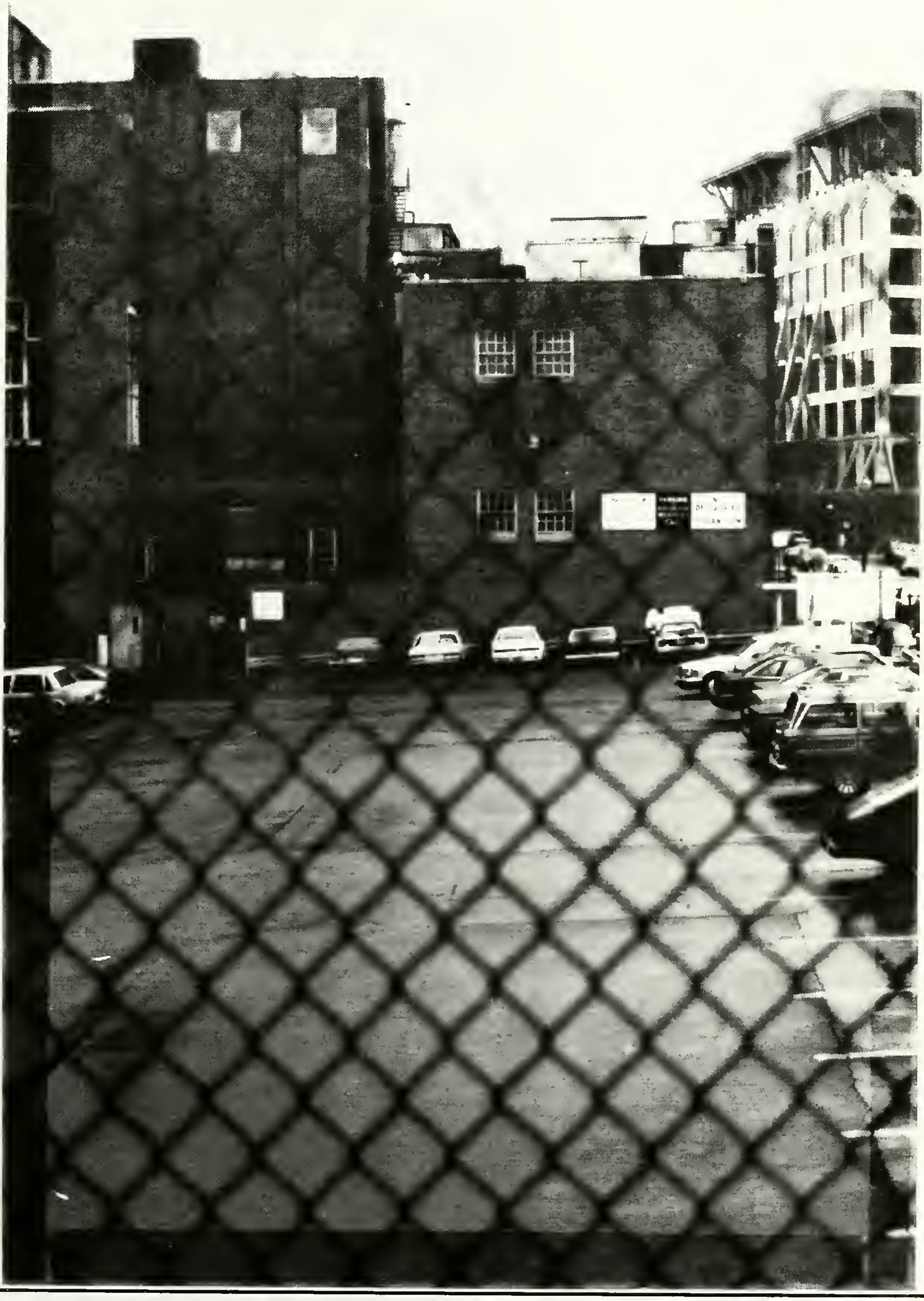

Figure V-1E
View of Site and Squash Court Building From Western Boundary of Site

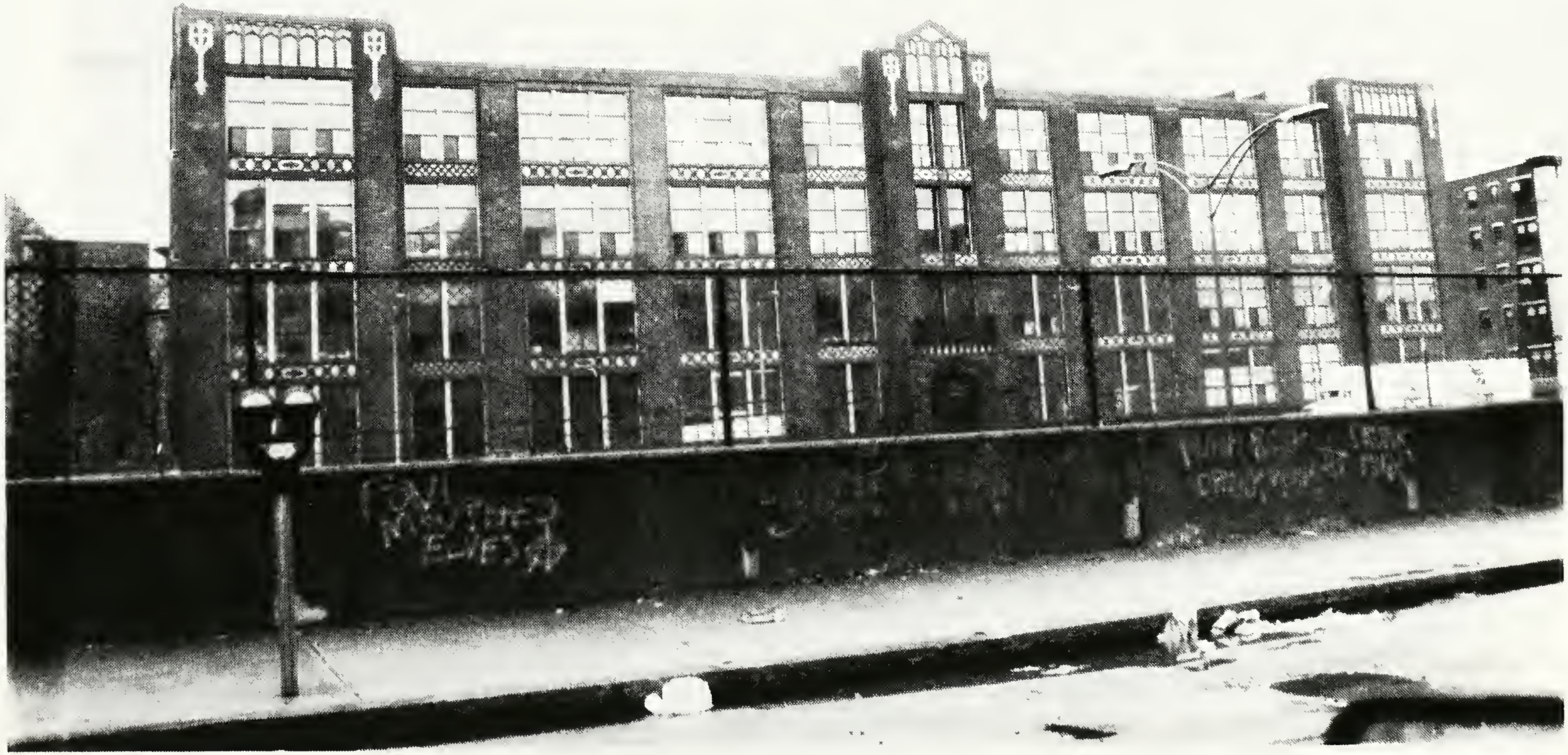

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Figure V-1F
View of Fenway Studios Building from Massachusetts Turnpike

Residential Condominiums and the rear of the Harvard Club of Boston. South of the proposed garage is Newbury Street, and south of Newbury Street is the retaining slope of the Massachusetts Turnpike. The Turnpike is built in the pre-existing railroad bed which accounts for the back-of-building facades facing the Turnpike. The one exception is the Fenway Studios building located directly across the Turnpike and of approximately the same scale, shape, and material as the proposed garage.

2.0 PROPOSED NEW CONSTRUCTION

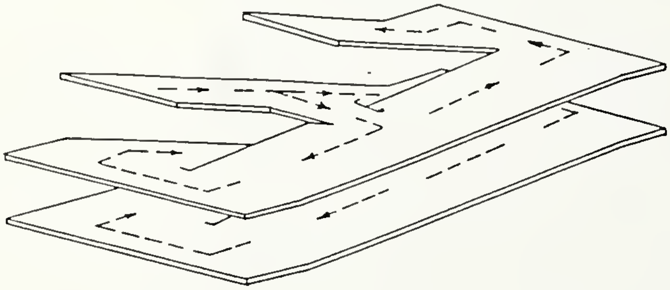
Location of Garage Entrance

The proposed project includes approximately 430 parking spaces on 8 levels, (6½ above-grade, 1½ below-grade). Because of the site configuration, the ramping system will be similar to that of the adjoining Somerset Garage, which is in fact, the only plan configuration practical for a site of its dimensions. The circulation is a continuous one-way ramp lined with angled spaces and provided with a central switch-back driveway. Corner towers will encase vertical pedestrian circulation as shown on the Ground Floor and Typical Plan, Figure V-2. The location of the entrance, as also shown on Figure V-2, eliminates a circulation conflict with the Somerset Garage and allows for queuing to take place in the driveway, thereby minimizing queuing on Newbury Street. A further description of queuing is included in the Transportation Component.

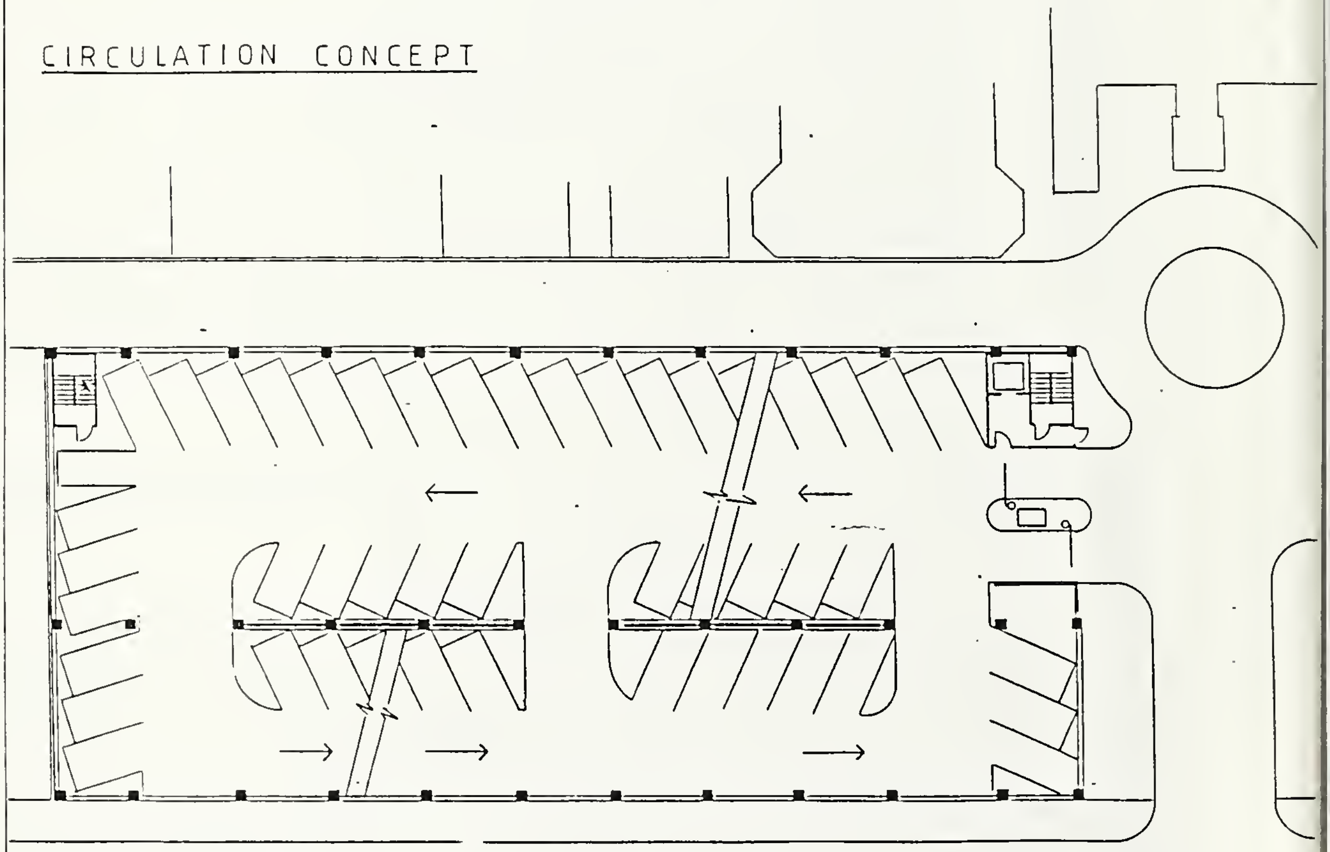
Use of Architectural Vocabulary and Building Materials Compatible with the Existing Features of the Back Bay

The proposed garage derives its massing and detail from three influences: the adjoining Somerset Garage (Figure V-1A), the facing Fenway Studios building (Figure V-1F), and the Harvard Club facade facing Commonwealth Avenue (Figures V-3 and V-4).

The height and shape of the Harvard Club Garage are consistent with the adjacent Somerset Garage. The proposed project reverses the ramping direction of the Somerset Garage to avoid the sawtooth affect of repeating the same slope (Elevations, Figure V-5 through V-7 and Perspective, Figure V-8).



CIRCULATION CONCEPT



ENTRY LEVEL

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Figure V-2
Ground Floor and Typical Plan

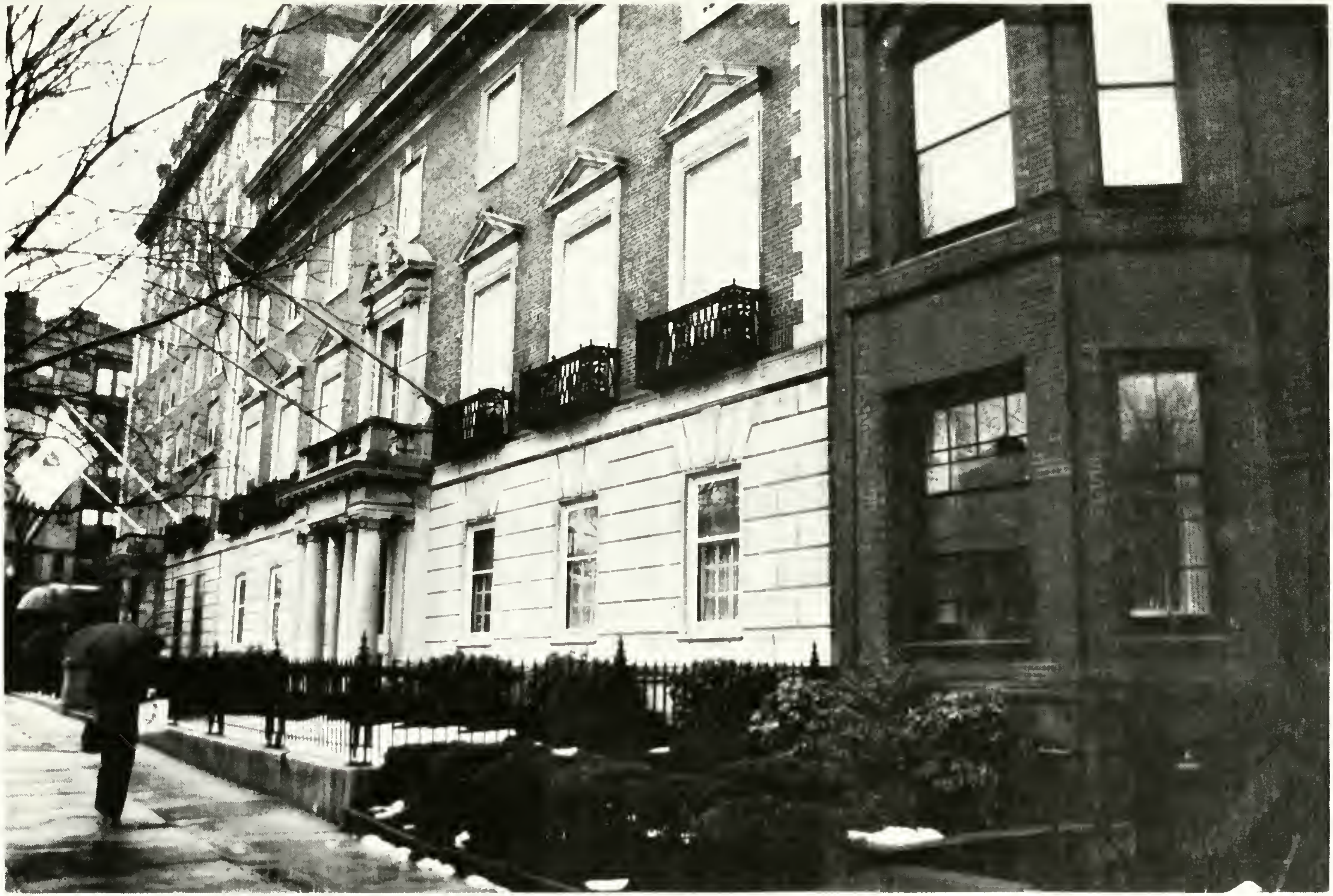

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Figure V-3
Harvard Club

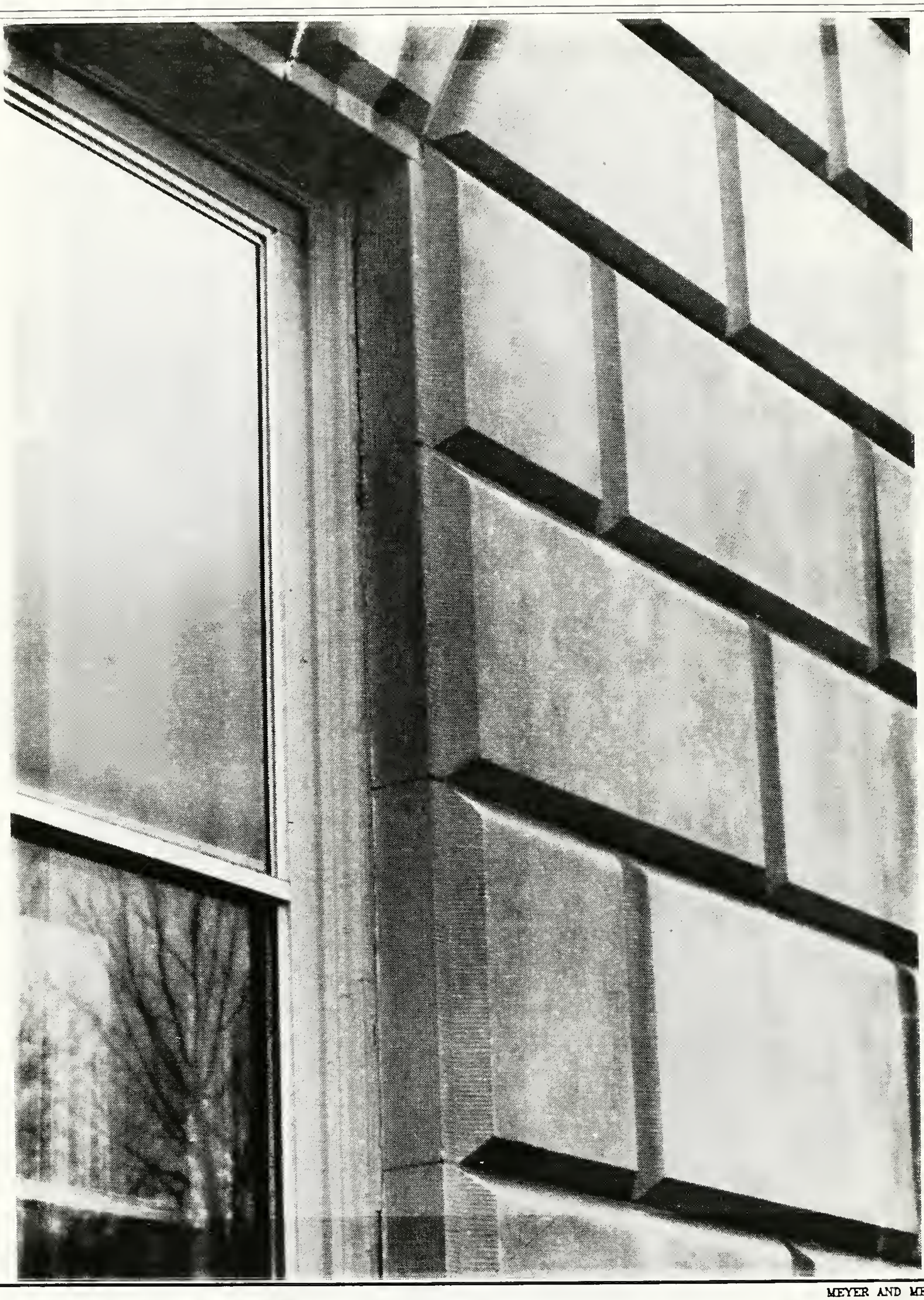

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Figure V-4
Stone Detail

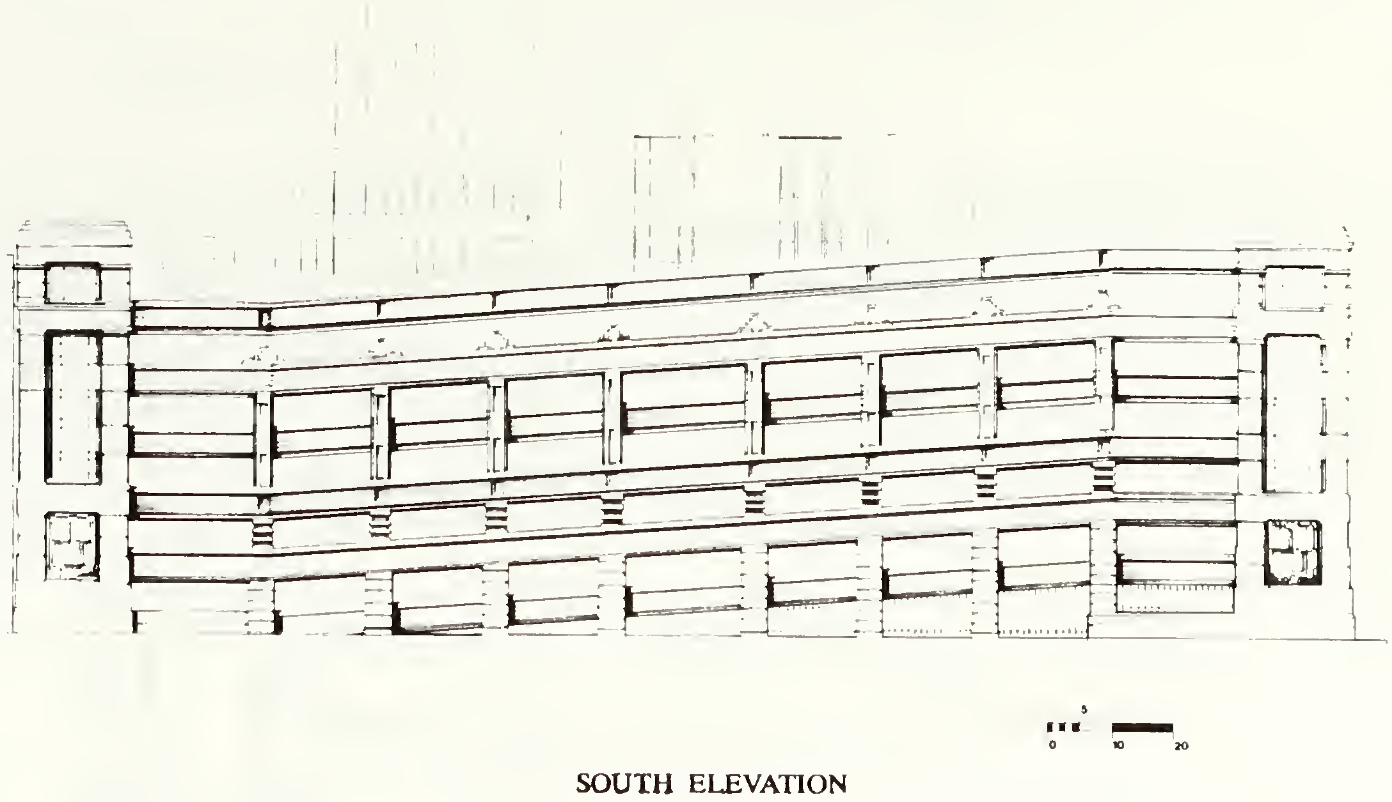

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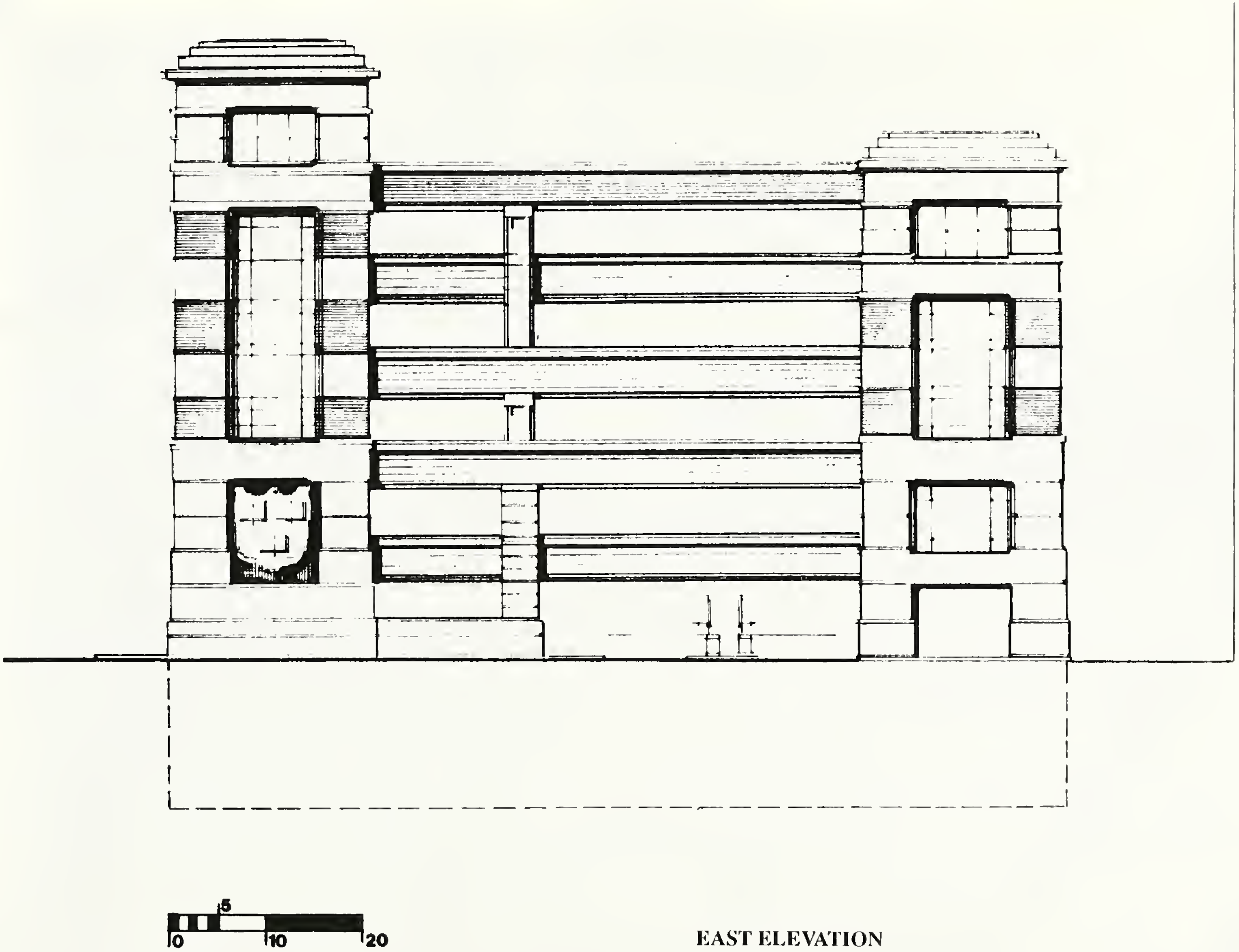
Figure V-5
South Elevation



Meyer & Meyer

Figure V-6
East Elevation

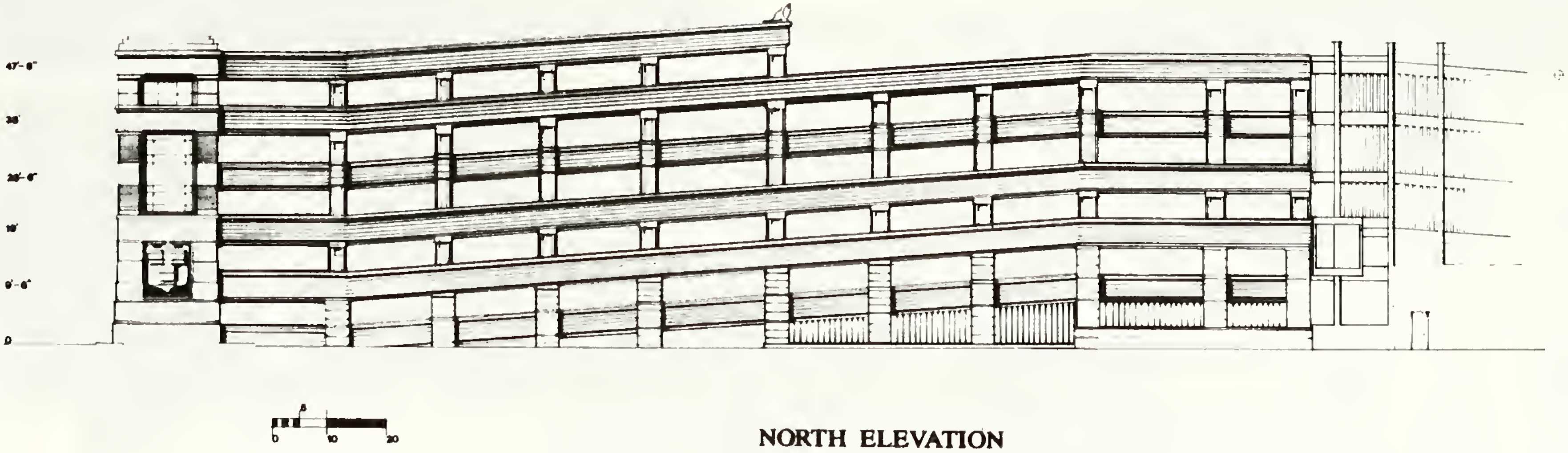


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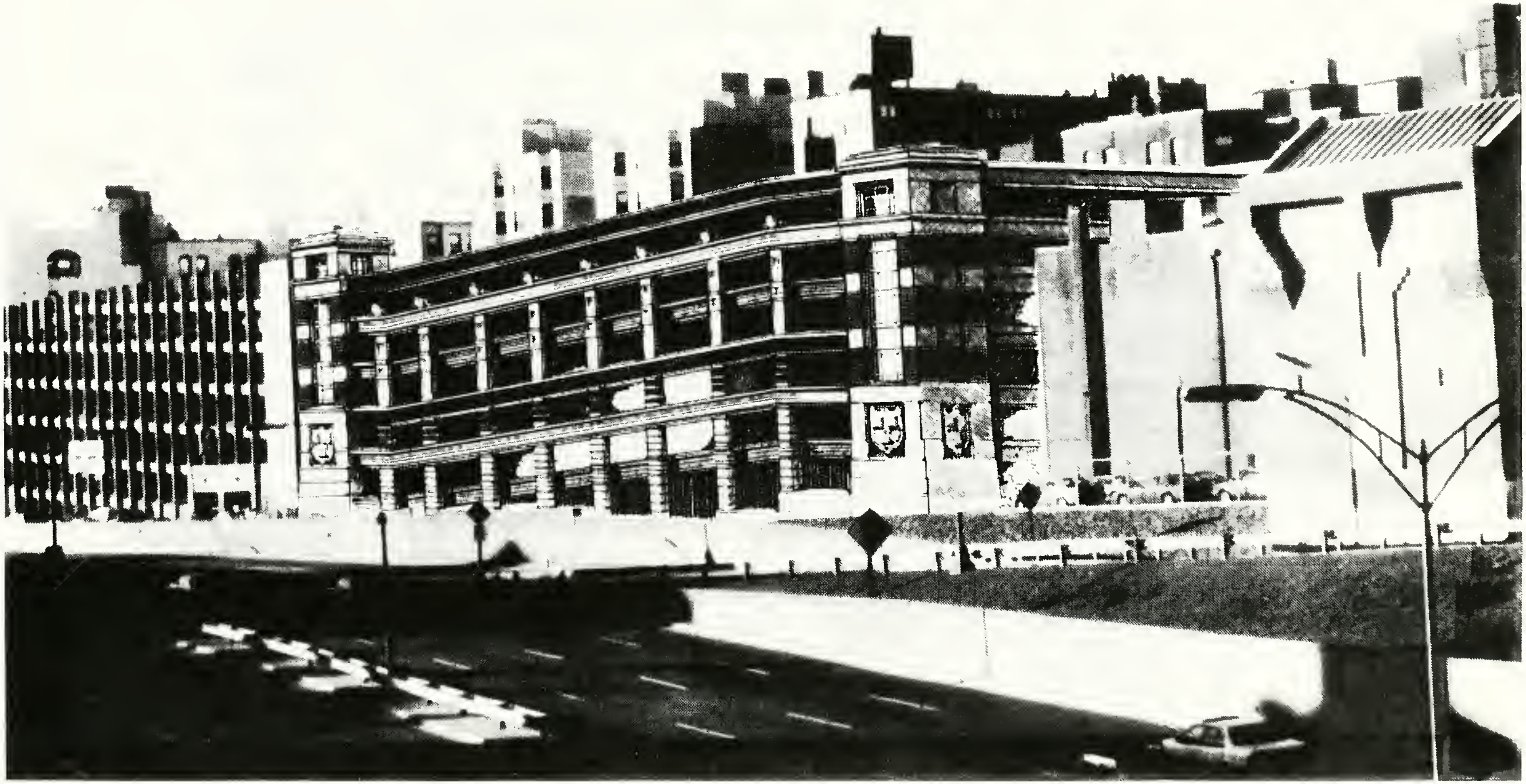
Figure V-7
North Elevation



Meyer & Meyer

Figure V-8
Perspective From Massachusetts Turnpike

The facade materials of the garage have been carefully selected to immediately match the Patina of traditional Back Bay buildings. Samples have been collected from various producers of precast concrete that, not only have the coloration and lightly sand-blasted surface of aged limestone, but also the seven light vertical gloves per inch which are common in turn-of-the-century stonework. Joint configurations have been copied directly from the Harvard Club's Commonwealth Avenue facade, with a quarter inch mortar groove set inside a 1 inch deep 45 degree bevel. Brick samples with complementary mortar color have been selected from new construction in the Boston area which most closely approximates a 19th Century brick color with 100 years of mortar discoloration. Tower copper caps will be acid treated for mossy green Patina at installation. Black iron will be painted as per neighborhood custom.

Treatment of Newbury Street Facade

The massing of the facade is related to the bookend Fenway Studios building across the Turnpike. The brick spandrel facade terminates with corner towers which accommodate vertical pedestrian movement. These towers create a clean break from the raw concrete garage to the west and provide an entry demarcation at the Harvard Club's back door.

Lighting

Lighting consultants have been retained to insure safe and aesthetic lighting for all spaces surrounding the building as well as in the garage.

Materials

The materials and facade elements are a result of the building's structural system, the desire to create a Harvard Club facade along the Turnpike, and the opportunity of matching elements to one of the city's more interesting buildings across the Turnpike.

The Club's desire to build an enduring structure, impervious to the destructive street chemicals of Boston, will force a more expensive structure. The cost premium for the difficult foundation conditions at this location allows the use of high quality facade finishes only if they can be incorporated into the structural parts of the building. To this end, designers have used concrete finishes to simulate the limestone base of the front facade of the Harvard Club. Brick and mortar colors and detailing on upper spandrel, column, and tower parts match both the Harvard Club front and the similarly colored Fenway Studios building across the Turnpike (Figures V-3 and V-1F). It should be noted that any reduction in parking levels will result in an identical layout with a less adorned exterior due to the cost of the foundation being distributed over fewer spaces.

Future Retail Convertability

Although it is presently difficult to imagine the marketability of a retail development on this end of Newbury Street which is beyond an active Turnpike entrance, the garage has been designed to allow ground floor retail space in the future. The ground-level Newbury Street parking row could be walled off from the rest of the garage and floor sections could be leveled to provide retail spaces.

Alley Treatment

Significant design is scheduled for ramp screening, landscaping, and appropriate finishes for the alley and alley side facade of the new garage. In addition, lighting consultants have been retained to ensure safe and aesthetic lighting for all spaces surrounding the garage. The Club will continue to meet with the abutters to discuss possible alley treatments which are beneficial and satisfactory to the City, the Club, and the abutters.

Architecturally Distinctive Round-About and Drop-Off Area

As described above, the Harvard Club of Boston recently completed a new round-about and drop-off at the Newbury Street entrance to the Club. Finish details include granite and brick paving, seating, and a skylighted vestibule which ties into the circulation system of the building.

3.0 ALTERNATIVE TO PROPOSED PROJECT

As described in the Executive Summary, after an extensive design review process, numerous community meetings and meetings with the BRA, the Harvard Club has also studied an alternative which includes a large 4-story notch cut into the corner of the proposed parking facility.

The notch will serve to open up light and views to and from the third floor pool deck at 388-390 Commonwealth Avenue and the residential units located immediately adjacent to the pool. The notch is a full parking space deep (approximately 20 feet), five parking spaces long (approximately 75 feet long), and four stories high (approximately 38 feet) beginning at the top of the third story. The horizontal levels created by the notched setbacks will be landscaped with colorful year-round vegetation. These setbacks will allow additional sunlight and air to the units facing the garage.

Three-dimensional computer modelings of the proposed notch are depicted in Figures V-9 through V-12. The first two modelings simulate conditions which would be seen from eye level at key locations.

Figure V-9 shows the view at ground level from within the existing alley looking east along the more articulated length of the proposed new structure. Although this alley accommodates service vehicles and limited pedestrian access, the proposed notch offers increased light to the ground level space below.

Figure V-10 highlights the view from the existing pool deck looking south. The areas created by the notch are to be completely landscaped with colorful and lively flowers and vegetation.

A leading landscape architect, William Pressley & Associates of Cambridge, who is the recent recipient of the City Design Awards for landscaping the Cambridge Center North Garage in Kendall Square, has been programming vegetation for the platforms created by the garage notch. Pressley's group has, in the past, created surprisingly lush environments for the tight spaces of various local parking structures including the Cambridge Center North Garage and Brook House in Brookline. His intention is to create a year-round garden composition to replace the present view from the pool deck across the existing surface parking lot to the Massachusetts Turnpike and buildings beyond.

Figure V-11 provides an aerial view looking down the length of the alley facing east and Figure V-12 provides an aerial view from above the circular drive rear entry to the Harvard Club looking west. Figure V-12 highlights the notch cut from the proposed parking garage as well as the corresponding notch created by the swimming pool area at 388-390 Commonwealth Avenue.

The proposed notch will eliminate 19 to 23 parking spaces.

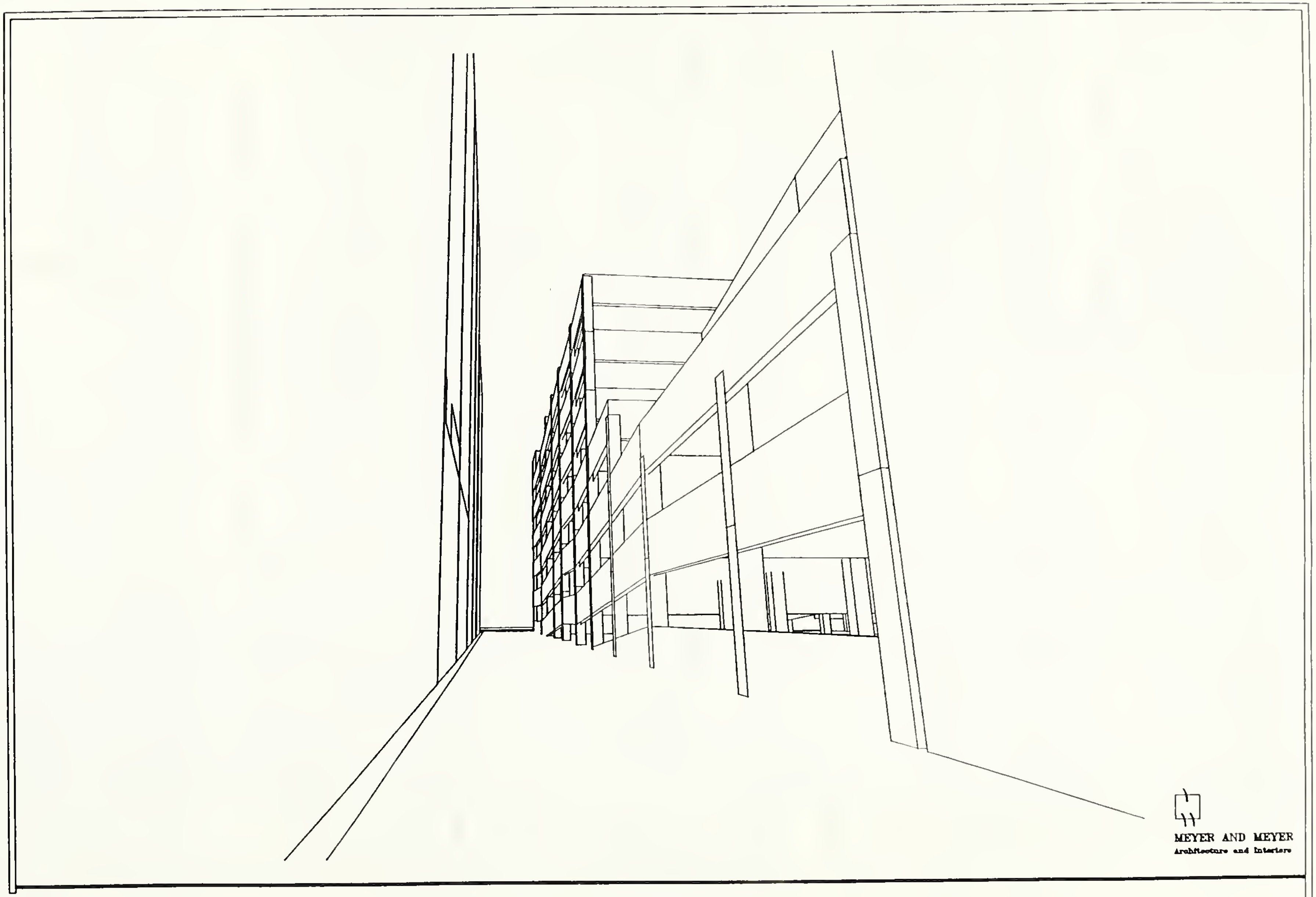


Figure V-9

View along the Alley

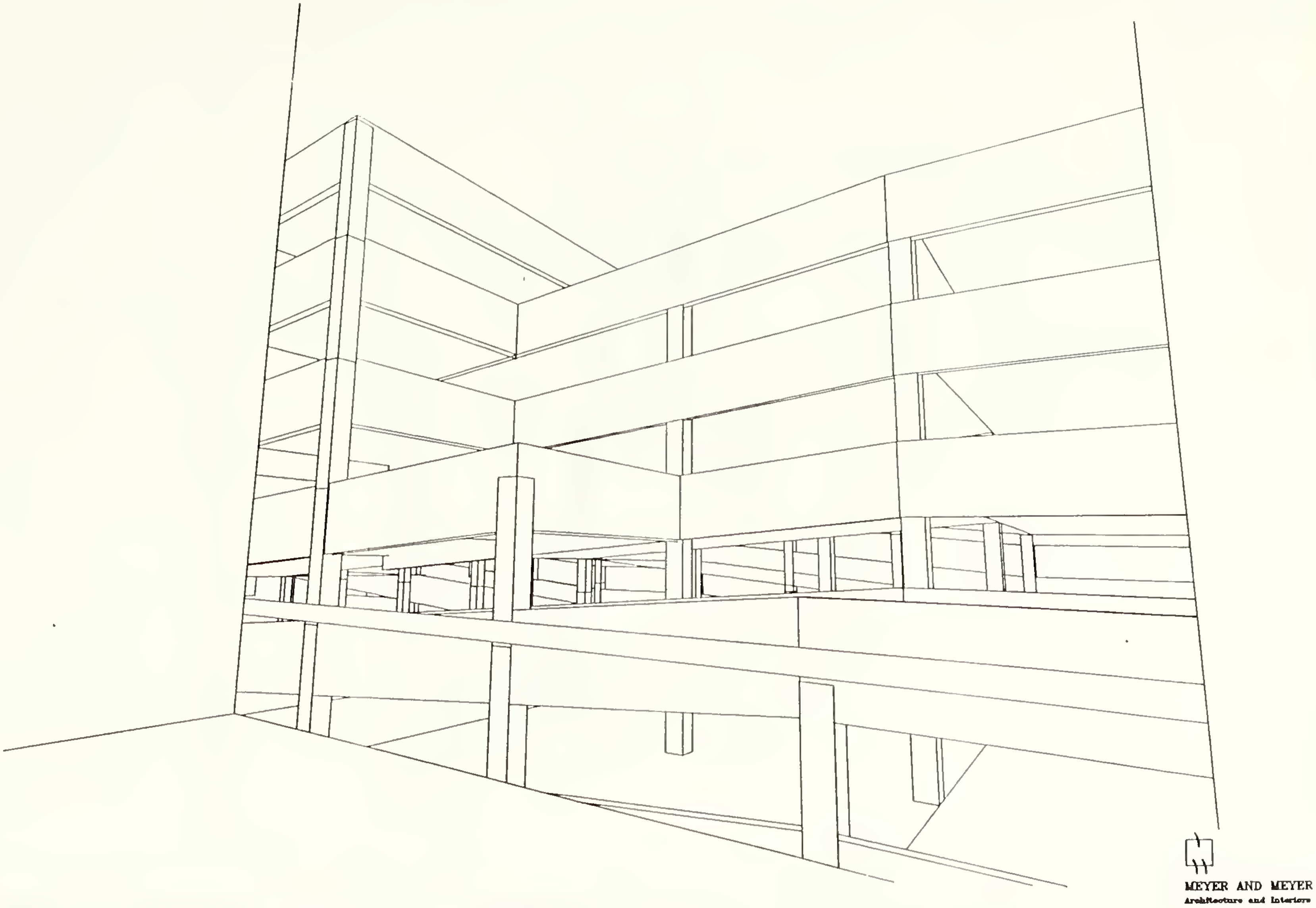


Figure V-10

View from Pool Deck

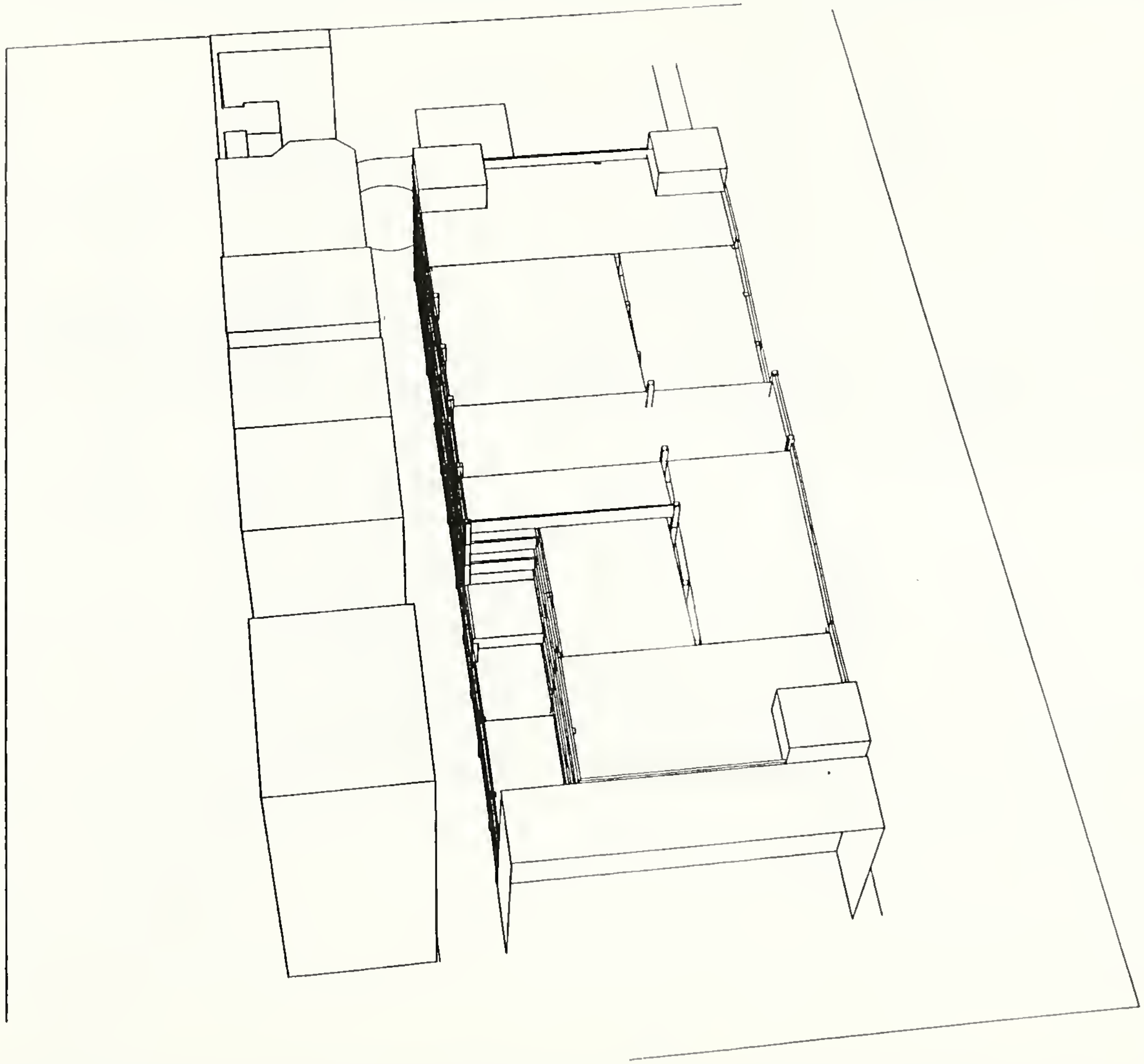


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Figure V-11

Aerial View down the Alley

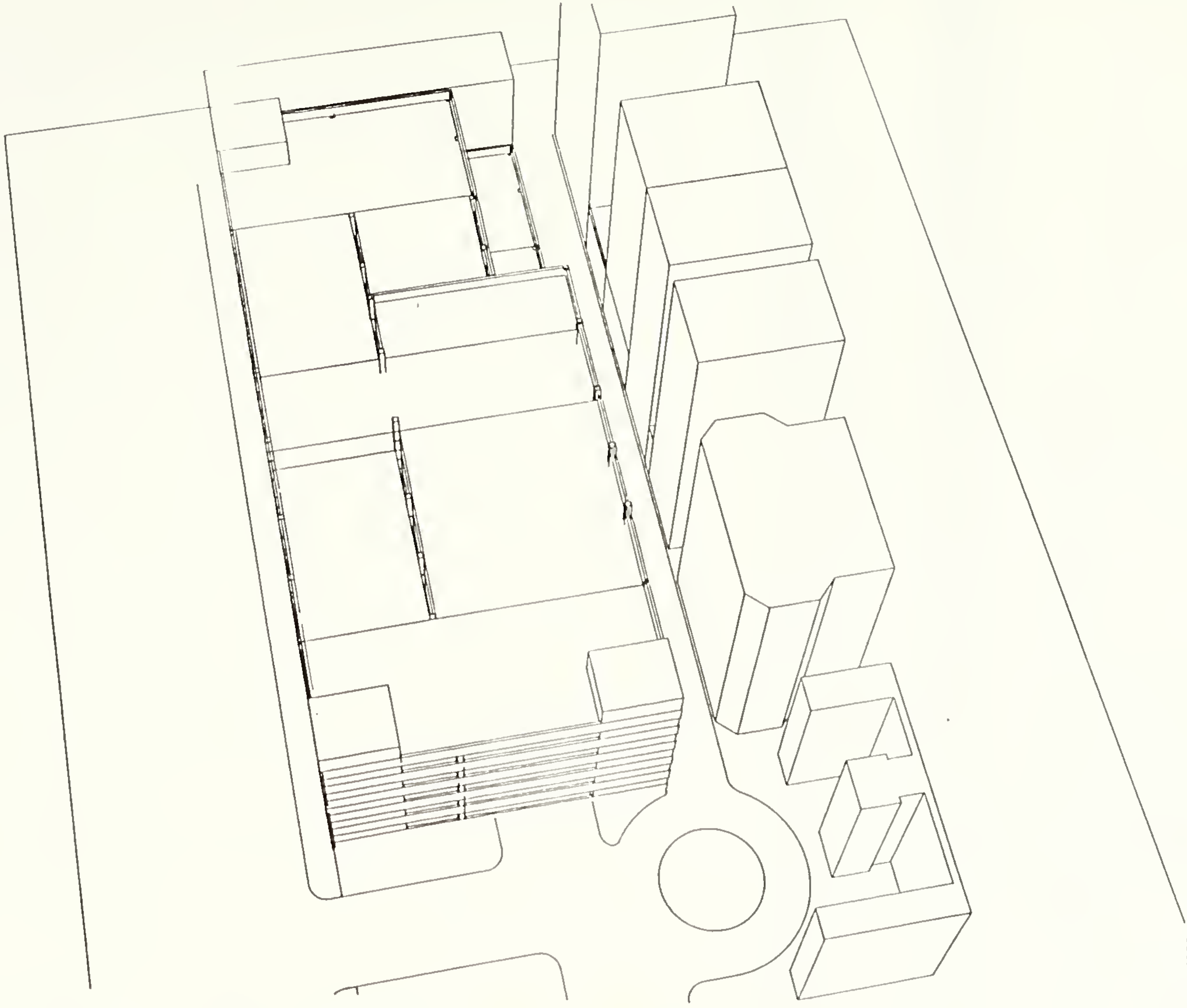

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Figure V-12

Aerial View from the Circular Drive
Rear Entry to the Harvard Club

4.0 DEVELOPMENT SCHEDULE

The project development team is confident the building will meet the combined objectives of the neighborhood, the Harvard Club, and the City of Boston. While the new building takes place entirely within the existing 2½ foot railing, and in no way realigns existing movement patterns, it does have the effect of filling a parking lot gap in the urban wall along the relatively new Massachusetts Turnpike.

The team plans to continue to meet with both the Boston Redevelopment Authority and the Back Bay Architectural Commission and to ensure the best product for all concerned parties. Construction is expected to begin in June of 1991 with completion in January 1992.

The schematic submission will be submitted under separate cover.

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VI. Historic Resources Component

VI. HISTORIC RESOURCES COMPONENT

1.0 INTRODUCTION

As requested in the Scoping Determination issued by the Boston Redevelopment Authority, the Historic Resources Component includes a description of the historic resources located near the proposed Harvard Club Garage. The proposed garage is located within the Back Bay Historic District and near the Hotel Somerset and the Puritan Hotel. The project is also located across the Massachusetts Turnpike from the Fenway Studios Building which is on the National Register of Historic Places. Through the appropriate use of materials, height, and massing, the proposed Harvard Club Garage has been designed to ensure its compatability with and minimize its impacts on nearby historic resources.

The Historic Resources Component is based on meetings and information collected at the Massachusetts Historical Commission (MHC) and the Boston Landmarks Commission (BLC).

2.0 HISTORIC RESOURCES IN THE PROJECT AREA

Back Bay Historic District

The Back Bay Historic District is primarily bounded by Boylston Street, Exeter Street, Stuart Street, St. James Avenue, Arlington Street, the Charles River and Charlesgate East.

According to the National Register of Historic Places Inventory-Nomination Form, the Back Bay is important as an example of early city planning, as a center of cultural activity, and because of its architecture. Originally a tidal backwash, the Back Bay was dammed and used for milling operations in the first half of the nineteenth century. During the second half of the 1800's, the tidal flats of the Back Bay were filled creating over 450 acres of land.

The heart of Back Bay, developed as a residential district with numerous recreation and park facilities, is known for its Victorian houses, primarily designed by accredited architects such as H.H. Richardson and McKim, Mead and White. In addition to its fame as a residential area, the Back Bay was also known as a cultural center and is home to the

Boston Public Library, the Museum of Fine Arts originally built in Back Bay but moved to Fenway in 1909, and the Museum of Natural History. On the edge of the Back Bay Historic District where the Harvard Club is located, is an area of mixed residential, commercial, religious and institutional uses. The strong cohesiveness and character of the Back Bay as a whole has been maintained through restrictions such as building height limits and confining of building materials to brick and stone masonry.

Historic Buildings

The following section provides a description of the buildings in the vicinity of the proposed Harvard Club Garage which are of special interest as outlined in the Scoping Determination. Figure VI-1 shows the location of the historic buildings.

Fenway Studios

The Fenway Studios building, made of brick and concrete, is located across the Massachusetts Turnpike from the Harvard Club Garage. The building, which is on the National Register, is significant as an unaltered building which has been in continuous use as artists' housing since its construction and as an example of the influence of the Arts and Crafts movement. The Arts and Crafts movement is reflected in the subtle geometric ornamentation of the pier-and-spandrel facade. The Arts and Crafts movement was based on a "preference for simplicity, respect for materials, common sense design, and distaste for historically derived forms." According to the National Register Of Historic Places Inventory-Nomination Form, the Fenway Studios building is the oldest example of an "unusual building-type which embodies design and style features related to its function."

Somerset Hotel and Puritan Hotel

The Somerset Hotel, located at 400 Commonwealth Avenue, was built in 1897 by A. Bowditch. Behind the 6 1/2 story limestone Somerset Hotel and adjacent to the Harvard Club Garage site is an existing seven story parking garage. The Puritan Hotel, located at 390 Commonwealth Avenue, was built in 1908 by E.B. Stratton. This seven-story building, made of brick and stone, has had two stories added, bringing it to nine floors, plus a basement. The Puritan Hotel also backs up to the existing parking garage. Both the

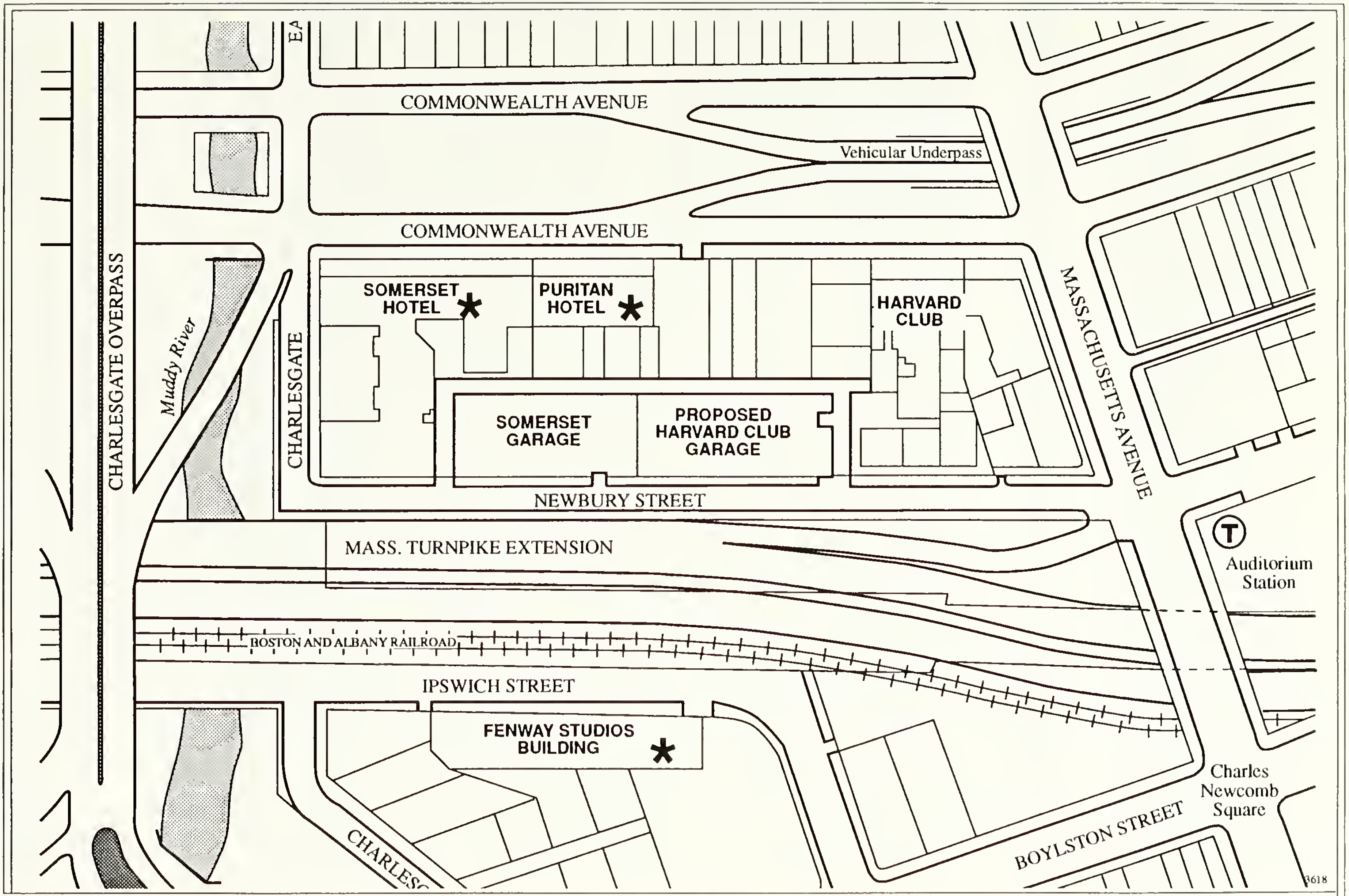

Figure VI-1
Historic Resources In Vicinity

Somerset and the Puritan Hotels have been converted to condominiums. The Somerset is entirely commercial, while the Puritan is both commercial and residential. Although not listed on the National Register, any possible impacts on these buildings will be a part of continuing discussion with the BLC and the Back Bay Architectural Commission (BBAC). Meetings have already been initiated with representatives of the BLC and the BBAC.

3.0 RELATIONSHIP OF PROPOSED PROJECT TO HISTORIC DISTRICTS AND BUILDINGS

The proposed garage is located in an area of the Back Bay Historic District where, due to the swath cut by the Massachusetts Turnpike and the barriers created by the Charlesgate Overpass and Massachusetts Avenue, the historic fabric of the Back Bay has been broken. All of the buildings along the Newbury Street extension actually front on Commonwealth Avenue or Massachusetts Avenue with their backs to Newbury Street. The Somerset Garage, adjacent to the site, is a seven-story concrete structure with little detail, further degrading the historic integrity of the area. The existing surface parking lot is a gap in the urban landscape, and contributes to the visual disruption in the area. Infilling this site to complete the street wall on Newbury Street will help define and organize the open space created by the Massachusetts Turnpike.

The Fenway Studios Building, which faces the proposed garage across from the Massachusetts Turnpike, was taken as inspiration for the form and materials proposed for the Harvard Club garage facade. Red brick with light precast trim and corner towers, and a center element for the proposed structure were drawn from the Fenway Studios Building.

The historical relationship of the proposed garage to the old Somerset and Puritan Hotels is practically non-existant. The historically interesting aspects of the hotels face Commonwealth Avenue. Their rear elevations are extremely undistinguished and are obscured by the existing Somerset parking garage. The proposed Harvard Club Garage will be shorter than either the Puritan or Somerset Hotel and thus will not be visible from Commonwealth Avenue. In addition, the Harvard Club Garage will not obscure the view of the tops of either hotel when viewed from the south.

4.0 ARCHAEOLOGY

Based on research conducted at the office of the Massachusetts Historical Commission, there are no archaeological resources within one-half mile of the site, and therefore the proposed Harvard Club Garage project is not anticipated to impact any archaeological resources.

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VII. Infrastructure Systems Component

VII. INFRASTRUCTURE SYSTEMS COMPONENT

1.0 INTRODUCTION

The Harvard Club is proposing to build a 430-space parking garage on the site of the existing surface parking lot located behind the Harvard Club. The site is on Newbury Street between Massachusetts Avenue and Charlesgate East and across from the Massachusetts Turnpike. Because of the size and use of the proposed project, the impacts on local infrastructure systems is expected to be minimal.

The Infrastructure Systems Component provides a description of the negligible anticipated water use, generation of sewerage and wastewater including measures to improve water quality, and anticipated energy use. Because the as-of-right alternative is expected to have the same minimal impacts as the proposed project, only impacts for the proposed project are presented in the report.

2.0 WATER USE

The proposed Harvard Club Garage is not expected to require any consumptive water use. As planned, the garage will not include any carwashing capabilities or other needs for water use. Garage employees will use existing sanitary facilities in the adjacent Harvard Club. In addition, the garage will have dry stand pipes located in the stair wells for fire protection. As a result, the garage is not expected to have an impact on the existing supply of water in the vicinity of the project.

3.0 WASTEWATER DISPOSAL

The site of the proposed Harvard Club Garage is served by separate sanitary sewer and storm drain systems. These systems, owned and operated by the Boston Water and Sewer Commission (BWSC), convey sanitary sewage to the Deer Island Wastewater Treatment Plant and storm drainage to the Charles River. There is presently and will be no stormwater discharge from the project site to the Muddy River.

The storm drain system from the project site consists of a 12-inch to 24-inch storm drain on Newbury Street. This drain flows to an 84-inch storm drain located on Charlesgate East. Although the BWSC Wastewater System Maps indicate that the 84-inch line is a combined sewer, it appears that it is only carrying stormwater flows. The 84-inch drain flows to a gate house near the Beacon Street/Storrow Drive interchange where the flows either discharge directly to the Charles River or are diverted into the Boston Marginal Conduit located under Storrow Drive which also appears to be carrying only stormwater flows at this point. Flows in the Boston Marginal Conduit are discharged to the Charles River through a number of overflows located along Storrow Drive. Figure VII-1 shows the existing sanitary sewers and storm drains in the project vicinity.

Stormwater flows from the project site are not anticipated to change appreciably as a result of the development of the garage. The site is presently impervious and will continue to be so after development. Much of the site runoff will consist of roof runoff which is typically considered "clean" compared to parking lot runoff which may potentially contain salt, oil and grease, and other contaminants. In order to protect water quality, and in fact possibly improve water quality, stormwater will be discharged to the storm drain system after passing through an oil/water separator. The separator will be designed and built to Massachusetts Water Resources Authority (MWRA) standards to prevent oil and gasoline from entering the storm drain system and will be inspected and maintained on a regular basis.

As described previously, because the proposed Harvard Club Garage does not include sanitary facilities, cooling or other water dependent uses, there is no expected sanitary waste as a result of the proposed Harvard Club Garage.

4.0 ENERGY SYSTEMS

Impacts on energy systems from the proposed Harvard Club Garage are anticipated to be minimal. Electricity use is expected to be limited to lighting in the booth area and lighting in the garage. The specific type of lighting has not yet been chosen, but will be energy efficient. The proposed project is not expected to use de-icing equipment or have any pavement heating or general heating for the garage. Energy requirements for the manned booth are expected to be limited to a light, telephone and probably a space heater, which is not unlike the existing booth on-site. Therefore the impacts on energy systems are expected to be minimal.

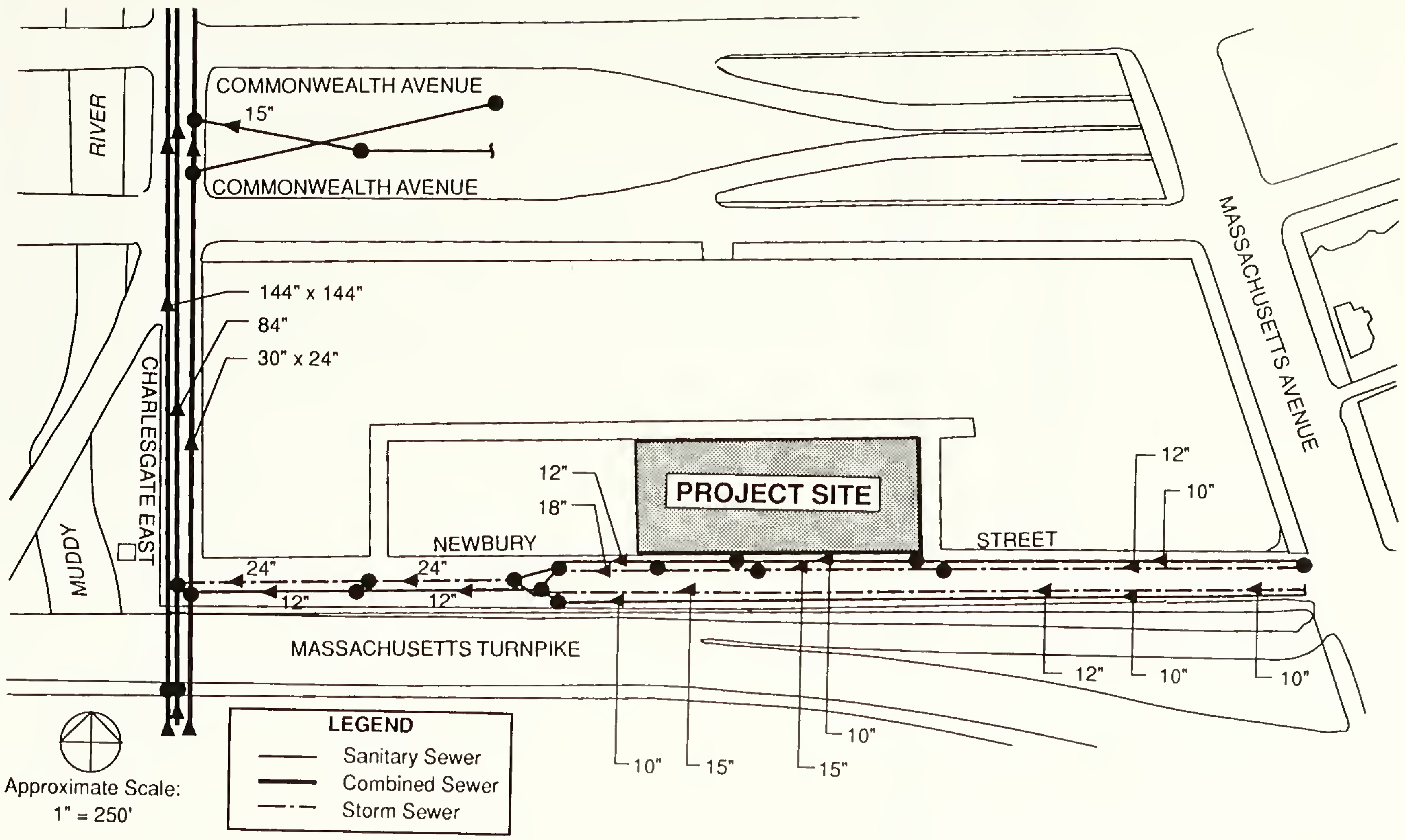


Figure VII-1
Existing Sanitary Sewers and Storm Drains in Project Vicinity

Appendices

APPENDIX A

SCOPING DETERMINATION

BOSTON
REDEVELOPMENT
AUTHORITY

Raymond L. Flynn
Mayor

Stephen Coyle
Director

One City Hall Square
Boston, MA 02201
(617) 722-4300

August 24, 1989

Mr. Franklin Mead III
President
Mead Consulting, Inc.
286 Congress Street
Boston, MA 02210

RE: Harvard Club Garage

Dear Mr. Mead:

Enclosed is the Scoping Determination for the Harvard Club Garage project for which you recently submitted a Project Notification Form ("PNF") pursuant to Article 31 of the Boston Zoning Code. The Scoping Determination requests information required by the Boston Redevelopment Authority in response to the PNF submitted.

Additional information may be required during the course of our review of the project. If you have any questions concerning the Scoping Determination or otherwise in connection with review of the Proposed Project, please contact Pamela Wessling at 722-4300, ext. 4232.

Sincerely,

Pamela Wessling

Pamela Wessling
Acting Assistant Director for
Urban Design and Development

Enclosure

Boston Redevelopment Authority is an Equal Opportunity/Affirmative Action Employer - Equal Housing Opportunity

BOSTON REDEVELOPMENT AUTHORITY

SCOPING DETERMINATION
HARVARD CLUB GARAGE

SUBMISSION REQUIREMENTS
FOR DRAFT PROJECT IMPACT REPORT (DPIR)

PROPOSED PROJECT:	Harvard Club Garage
PROJECT LOCATION:	Newbury Street Boston, MA
APPLICANT:	Harvard Club
PNF SUBMISSION DATE:	July 12, 1989

The BRA is issuing this Scoping Determination pursuant to Section 31-5 of the Boston Zoning Code (the "Code"). The applicant filed a Project Notification Form ("PNF") on July 12, 1989. The Scoping Determination requests information required by the Boston Redevelopment Authority ("BRA") for its review of the Proposed Project in connection with the following:

a) Development Review pursuant to Article 31 of the Code; and

b) Recommendations to the Board of Appeal with respect to the zoning relief required for the Proposed Project, pursuant to Articles 6, 7, and 27D of the Code.

PREAMBLE

The BRA is reviewing the Proposed Project pursuant to multiple sections of the Code. The Proposed Project is being reviewed pursuant to Article 31 of the Code, Development Review Requirements, which sets out a comprehensive procedure for project review and requires the BRA to review the design, transportation, environmental, and other impacts of proposed projects. Article 31 requires the submission of a satisfactory Final Project Impact Report ("FPIR") prior to the issuance of a building permit.

In addition, the Proposed Project requires zoning relief in the following three forms: one conditional use permit, four variances, and one IPOD permit. In order to be granted each type of zoning relief, a different set of criteria must be satisfied.

The Proposed Project requires a conditional use permit for parking in a Restricted Parking District. Conditions required for approval of conditional use permits are outlined in Section 6-3 of the Code. However, because this conditional use permit is specifically sought for a parking use in a Restricted Parking

District, additional conditions must be satisfied, as set forth in Section 6-3A.

In addition, the Proposed Project requires four variances, including those which pertain to requirements governing FAR, rear yard, front yard and parapet setbacks. To receive these variances, in each case it must be demonstrated that the conditions required for a variance are satisfied, in accordance with Section 7-3 of the Code.

The Proposed Project also requires an IPOD permit. To receive such a permit, the Proposed Project must meet the following standards, in accordance with Section 27D-14:

- o the Proposed Project's benefits must outweigh the burdens imposed; and
- o the Proposed Project must be in substantial accord with the applicable provisions of Article 27D.

The substantive review requirements imparted by these sections address related, but not identical, issues which are the basis of Article 31 review. The reviews, however, overlap to a significant degree. Therefore, the BRA is incorporating its review of zoning relief for the Proposed Project into the Article 31 process to eliminate regulatory duplication and consolidate the Proposed Project's review into one process and one set of documents.

I. HARVARD CLUB GARAGE PROPOSED PROJECT DESCRIPTION

The site of the Proposed Project is located on Newbury Street to the west of Massachusetts Avenue and to the north of the Massachusetts Turnpike. The site area is approximately 19,672 square feet and presently is vacant and operated as a surface parking lot with 110 spaces.

The Harvard Club proposes to build a new 157,092 square foot parking garage containing 430 parking spaces. The Proposed Project will measure 65 feet in height and contain eight levels of parking, including one level below grade, resulting in an FAR of 7.

This Scoping Determination requires evaluation of two project programs:

1. One alternative must be a garage which conforms to the standards set forth in the Downtown IPOD, which allows an as-of-right FAR of 3. This alternative would still require zoning relief in the form of a conditional use permit for parking and variances for minor violations of setback requirements.

2. The second alternative is the applicant's preferred 430 parking spaces.

II. DOWNTOWN INTERIM PLANNING OVERLAY DISTRICT

On September 25, 1987, the Boston Zoning Commission amended the Zoning Code to incorporate Article 27D, the Downtown Interim Planning Overlay District ("IPOD") in order to facilitate rezoning of the land in the Downtown area and provide the proper balance between competing land uses, economic, and environmental factors.

Pursuant to Article 27D, the Proposed Project is located within the Downtown IPOD in Subdistrict B, a Priority Preservation Subdistrict, in which the height standard is 65 feet, and the floor area ratio standard is 3. The underlying zoning for the Proposed Project is H-3-65. The Proposed Project is within the height standard but violates the FAR standard.

In accordance with Section 27D-4, the Proposed Project should reflect the general land use objectives for the Priority Preservation Subdistrict, which are:

- to preserve the present uses, architectural scale, and historic character of the area; and
- to emphasize the conservation, rehabilitation, and restoration of existing structures, in the case of new development.

III. DEVELOPMENT REVIEW REQUIREMENTS - ARTICLE 31

Article 31 of the Code institutes a process by which large-scale development projects will be reviewed by the BRA. As previously stated, the BRA is issuing this Scoping Determination pursuant to Section 31-5. The Draft Project Impact Report must conform to Article 31 and to this Scoping Determination.

SUBMISSION REQUIREMENTS

In addition to full-size scale drawings, 20 copies of a bound booklet containing all of the following submission materials reduced to size 8 1/2" x 11", except where otherwise specified, are required. In addition, an adequate number of copies must be available for community review.

Information required below must be provided in the DPIR for both program alternatives, except where the information would be identical.

I. GENERAL INFORMATION

1. Applicant Information

- A. Development Team
  - 1. Names
    - a. Developer (including description of development entity)
    - b. Attorney
    - c. Project consultants
  - 2. Business address and telephone number for each
  - 3. Designated contact for each
  - 4. Description of current or formerly-owned developments in Boston
- B. Legal Information
  - 1. Legal judgments or actions pending concerning the Proposed Project
  - 2. History of tax arrears on property owned in Boston by development team
  - 3. Evidence of site control over the project area, including current ownership and purchase options of all parcels in the Proposed Project, all restrictive covenants and contractual restrictions affecting the Applicant's right or ability to accomplish the Proposed Project and the nature of the agreements for securing parcels not owned by the Applicant
  - 4. Nature and extent of any and all public easements into, through, or surrounding the site

2. Financial Information

(See Appendix 1 for required financial information to be submitted to the BRA under separate cover from the DPIR.)

- A. Full disclosure of names and addresses of all financially involved participants

B. Development Pro Forma

C. Ten Year Operating Pro Forma

3. Project Area

A. Description of metes and bounds or certified survey of project area

4. Public Benefits

A. Description of the public benefits which would result from the Proposed Project

5. Employment

A. Anticipated employment levels including the following:

1. Estimated number of construction jobs

2. Estimated number of permanent jobs

6. Regulatory Controls and Permits

A. Existing zoning requirements, zoning computations, and any anticipated requests for zoning relief

B. Anticipated permits required from other local, state, and federal entities, with a proposed application schedule

7. Community Groups

A. Names and addresses of project area owners, displacees, abutters, and any community groups which, in the opinion of the Applicant, may be substantially interested in or affected by the Proposed Project

B. A list of meetings proposed and held with interested parties including but not limited to the Back Bay Association, the Neighborhood Association of the Back Bay, and the Back Bay Architectural Commission

8. Tax Revenues

A. Increase in tax revenue payments, specifying existing and estimated annual property taxes

9. Project Schedule

A. Anticipated development schedule

B. Estimated completion

II. TRANSPORTATION COMPONENT

The Transportation Access Plan required pursuant to Section 31-6 must analyze the impact of the Proposed Project with respect to vehicular access and circulation and proximity to other transportation systems. By its design management, the Proposed Project should emphasize feasible measures to be undertaken to limit the impact of the Proposed Project on any traffic congestion.

The following comments and submission requirements incorporate those of the Boston Transportation Department ("BTD") regarding transportation issues and objectives for the Proposed Project.

1. Traffic Management Element

For the purposes of analyzing traffic impacts of the Proposed Project, no-build and build conditions should be compared for the year 1994. This horizon year will allow use of background traffic analyses already performed in connection with the Prudential Center Redevelopment and contained in the Draft Project Impact Report for that project.

A. Existing Conditions

1989 traffic volumes and levels-of-service must be presented for analysis intersections in the AM, PM, weekend, and periods affected by special events (i.e. Red Sox games).

B. Background Development

No-build conditions for the Proposed Project must include traffic generated by the projects analyzed for the 1994 build of the initial phase of the Prudential Center Redevelopment

C. Project Impacts

Analysis of vehicular traffic operations must include the following information for all alternatives in the AM, PM, weekend peak hours, and periods effected by special events:

- Vehicular trip generation
- Analyses of project impacts which reflect mid-block congestion resulting from double parking and other obstructions, pedestrian conflicts, queuing

from one intersection to another, servicing and loading, and other operational delays (If necessary, traffic conditions should be expressed in terms of arterial level-of-service.)

- Level-of-service analyses at the following intersections:

    1. Massachusetts Avenue and Newbury Street
    2. Charlesgate East and Commonwealth Avenue (east- and west-bound)
    3. Massachusetts Avenue and Commonwealth Avenue (east- and west-bound)

- Estimated truck and service vehicle traffic to the site

2. Parking Management Element

The DPIR must include the following:

A. A review of existing reports and studies to characterize the existing parking conditions in the Back Bay Resident Parking District (bounded roughly by Arlington Street to the east, Boylston Street to the south, Charlesgate East to the west, and Back Street to the north). This review must include the supply of and demand for parking by user type (private, commercial, residential) and the average price for each type of parking.

B. Projected change in background parking supply by 1994 by type (private, commercial, residential)

C. The number of spaces proposed, indicating allocation of spaces to each use. For examination of Alternative 2, at a minimum the following two scenarios of space allocation during peak hours must be studied:

   a) To reflect the priorities of the Restricted Parking District in which parking is allowed if it is accessory or ancillary to a residential use, one scenario shall include the following allocation: 140 spaces reserved for Harvard Club members; 100 short-term commercial spaces; 190 monthly lease spaces.

   b) For sensitivity analysis purposes, a second scenario shall include the following space allocation: 140 spaces reserved for Harvard Club members; 250 short-term commercial spaces; 40 monthly lease spaces.

Note: Under these alternatives, it should be assumed that shared use will result in a larger number of spaces being available for particular uses. For example, Harvard Club demand in excess of 140 spaces can be satisfied by surplus commercial and monthly spaces in off-peak hours. Furthermore, as with alternative 1, this alternative must include consideration of making parking spaces available for use by Back Bay residents during off-peak hours.

D. Parking plan for each alternative, including layout, access, size of spaces, the level of utilization of spaces by different user types, and the location of ticket booth or gate.

E. Detailed discussion of parking management program. Include discussion of variations of alternative 2 in terms of their effect on the Back Bay commercial and residential communities as well as their financial feasibility. Describe management methods, including rate and payment options which will maximize the availability of overnight parking to Back Bay residents. Address potential overlap in peak accumulation hours of different use types, and discuss measures which will mitigate conflicts (such as leaving commercial spaces closed until 9:00 AM, after residential users have left).

3. Pedestrian Circulation

A. The pedestrian circulation evaluation must assess the effect of the Proposed Project on pedestrian circulation patterns for the year of full occupancy (1992) and address the following:

- Pedestrian conditions on Newbury Street in the vicinity of the site including identification of pedestrian activity, circulation deficiencies and barriers, and measures to improve such conditions
- Connections to public transportation station stops
- Effect on pedestrian flows of Proposed Project and servicing entrances and exits
- Identification of pedestrian corridors including indoor and outdoor connections open to the public, hours of operation and security arrangements for interior passageways
- Identification of pedestrian barriers and qualitative circulation deficiencies and measures to improve such conditions

B. Measures to manage and reduce impacts on the pedestrian environment including but not limited to:

- Improvements to pedestrian environment
- Street lighting along the public alley behind the garage, along Newbury Street, and in the drop-off zone for the Harvard Club

4. Loading and Internal Circulation

The following information must be included as part of the Draft Project Impact Report:

- Demand for loading generated by different uses
- Size and maneuvering space on-site or in public right-of-way, and the internal maneuvering space for trucks of all sizes, especially with regard to the disruption of on-street traffic flow by trucks backing in or out
- Access, curb cuts, and/or sidewalk changes required

5. Construction Management Element

The following information must be included as part of the Draft Project Impact Report:

A. Management Plan

- Hours of construction activity
- Maximum number of construction workers and vehicles per day
- Number of affected travel lanes; location of affected intersections and the extent to which they are affected; location of affected sidewalks and the extent to which they are affected
- Location of staging and the extent to which it affects the site
- Construction vehicle timing and routes of deliveries to the proposed project
- Location of construction vehicle and worker parking (on or off site)
- Route of any detours, pedestrian or vehicular caused by construction

B. Mitigation measures for impacts on pedestrian and vehicular traffic including:

- Worker parking and commuting plan
- Alternate modes of transport for employees and materials to and from the site and restrictions on schedules and routes of vehicular movements
- Staggered hours for vehicular movement
- Traffic controllers to facilitate equipment and trucks entering and exiting the site
- Covered pedestrian walkways
- Location of construction staging areas
- Measures to protect the public safety and ensure vehicular and pedestrian access onto and through streets in the area of the proposed project
- Appropriate construction equipment and proper storage of materials and equipment
- Alternative construction networks and construction planning

C. Designation of a liaison between the Proposed Project, public review agencies, and the surrounding business and communities

In addition to the foregoing Construction Management Requirements, the Boston Transportation Department requires the submission of a Traffic Maintenance Plan in conformity with the City's Construction Management Program. The requirements for the Traffic Maintenance Plan are attached as Appendix 2.

6. Monitoring Element

A long-term program to monitor the travel behavior of the project tenant and other users of the site must be submitted. Information to be gathered includes travel mode, vehicle occupancy rate, and employee/member origin-destination surveys.

III. ENVIRONMENTAL PROTECTION COMPONENT

1. Air Quality

A description of existing air quality in the vicinity of the Proposed Project. An air quality (carbon monoxide) analysis is required for any intersection where level of service is expected to deteriorate to D and the project is expected to cause a ten percent increase in the level of traffic or where the level of service is already E or F and the project contributes to a reduction of level of service.

A description of the garage exhaust system, including location of exhaust vents and specifications, and an analysis of the impact on pedestrian level air quality from operation of the exhaust system is required. The impact on adjacent residential properties, including the Harvard Club, must be evaluated. Measures to avoid any violation of air quality standards must be described.

In addition, the DPIR must include a discussion of the Proposed Project's impacts to the tropospheric (ground-level) ozone on a regional scale.

2. Solid and Hazardous Wastes

The presence of any contaminated soil or groundwater must be identified, and measures that will be employed to ensure their safe containment, removal or disposal shall be described.

The generation of solid wastes (construction period and operation of the project) and plans for removal and disposal must be described.

3. Noise

Anticipated long-term noise increases from project-generated traffic and from the project's building mechanical equipment must be evaluated. Measures to minimize noise impacts must be described.

Evaluation of existing (1989) and future (1992) noise increases from traffic along Newbury Street as a result of the Proposed Project must be conducted.

4. Water Quality and Resources

An evaluation of the impact of the project on water quality and marine resources of the Muddy River is required and must include potential impacts during construction from building demolitions, pile driving, platform construction, and site dewatering and potential impacts after completion. The types of piles to be installed and the types of preservations (if piles are wooden) also must be described. Mitigation measures to prevent degradation of water quality from construction activities must be described. Site drainage and measures to prevent water pollution from site runoff, particularly from roadways and parking areas, must be described in tr DPIR.

5. Geotechnical Impact

An analysis of existing sub-soil and groundwater conditions, potential for ground movement and settlement during excavation, and potential impact on adjacent buildings and utility lines is required. This analysis must also include a description of the foundation construction methodology, the amount and method of excavation, and measures to prevent any adverse effects on adjacent buildings and utility lines.

If the Proposed Project includes underground parking which requires excavation below the existing water table an analysis of the impact of foundation construction on the maintenance of ground water levels and on foundation supports (e.g., wood piles) of adjacent structures is required. Measures to ensure that groundwater levels will not be lowered during or after construction must be described.

6. Construction Impacts

A construction impact analysis must be provided including a description and evaluation of the following:

A. Potential dust and pollutant emissions and mitigation measures to control these emissions

B. Potential noise impact and mitigation measures to minimize increase in noise levels

C. Location of construction staging areas and construction worker parking

D. Construction schedule, including hours of construction activity

E. Access routes for construction trucks and anticipated volume of construction truck traffic

F. Foundation construction methodology, amount and method of excavation, impact on adjacent buildings and groundwater levels, and measures to prevent adverse effects on adjacent buildings and groundwater levels

G. Measures to protect the public safety

7. Rodent Control

An analysis of the impact of project construction on rodent populations and a description of the proposed rodent control program and compliance with applicable City and State regulatory requirements is required.

IV. URBAN DESIGN COMPONENT

The DPIR must address the Urban Design Standards set forth in Section 8 of Article 31 of the Code as well as the urban design objectives of the Downtown IPOD. Following is a list of variables which must be addressed in urban design studies to be prepared in consultation with the BRA prior to finalizing the alternatives to be studied in detail in the DPIR:

- Location of garage entrance which minimizes traffic stacking-up on Newbury Street
- Architectural vocabulary and building materials which are compatible with the existing features of the Back Bay; window patterns, rooftops, and finishing material should relate (abstractly) to the existing Back Bay features
- Treatment of the Newbury Street facade which is designed in a manner that breaks the horizontality of the block into smaller vertical elements which vary in width.
- Adequate street lighting along the public alley, along Newbury Street, and the club entrance road
- Ramps which enable the future creation of pedestrian oriented spaces along Newbury Street
- Architecturally distinctive round-about and drop-off area which uses different materials and colors without blocking service trucks or safety vehicles from entering the public alley
- Flexible design solution for the ground level such that the frontage along Newbury Street could be converted from a parking garage into retail space in the future

In order to determine that the Proposed Project is (a) architecturally compatible with surrounding structures; (b) exhibits an architectural concept that enhances the urban design features of the subdistrict in which it is located; (c) augments the quality of the pedestrian environment; and (d) is consistent with the established design guidelines that exist for the area, the following design materials must be submitted:

A. Written description of program elements and space allocation for each element

B. Plan for the surrounding area and district and section at an appropriate scale (1" = 40' or larger) showing relationships of the Proposed Project to the surrounding area's and district's:

   - Massing
   - Building height
   - Scaling elements
   - Public space/open space
   - Major topographic features
   - Pedestrian and vehicular circulation
   - Land use

C. Black and white 8" x 10" photographs of the site and neighborhood

D. Sketches, diagrams, and photographs where relevant, to clarify design issues and massing options

E. Eye-level perspective(s) (reproducible line drawings) showing the proposal in the context of the surrounding area

F. Aerial views of the project

G. Site sections at 1" = 20' or larger showing relationships to adjacent buildings and spaces

H. Site plan at an appropriate scale (1" = 20') or larger showing:

   - General relationships of proposed and existing adjacent buildings and open space
   - Open spaces defined by buildings on adjacent parcels and across streets
   - General location of pedestrian ways, driveways, parking, service areas, streets, and major landscape features
   - Pedestrian, handicapped, vehicular and service access and flow through the parcel and to adjacent areas
   - Survey information, such as existing elevations, benchmarks, and utilities

- o Phasing possibilities
- o Construction limits

I. Drawings at an appropriate scale (1" = 8' or larger) describing architectural massing, facade design and proposed materials including:

- o Site improvement plans
- o Elevations in the context of the surrounding area
- o Sections showing organization of functions and spaces
- o Preliminary building plans showing ground floor and typical upper floor(s)

J. Proposed schedule for submittal of design development materials

V. HISTORIC RESOURCES COMPONENT

The DPIR must include an historic resources analysis that assesses the effect of the Proposed Project's height, scale, massing, and other relevant environmental factors on historic districts and buildings, including:

1. National or Massachusetts Register or Register-eligible sites, districts and other architecturally significant areas:
   - o Back Bay National Register District
2. Buildings recommended for the National and Massachusetts Registers by the Boston Landmarks Commission in proximity to the site:
   - o Hotel Somerset
   - o Puritan Hotel

The DPIR must indicate how the Proposed Project effects the character of the districts and buildings identified in paragraphs 1 and 2 above. In addition, any adverse impact on the characteristics which make the districts and buildings identified in paragraphs 1 and 2 eligible for the National or Massachusetts Register must be identified and mitigated.

The DPIR should also include an assessment of the potential presence of any archaeological resources which may be disturbed by the construction of the

Proposed Project.

VI. INFRASTRUCTURE SYSTEMS COMPONENT

The Infrastructure System Component of the DPIR must address anticipated volume requirements and generation for water, sewerage, storm drainage, electricity/energy, telephone, gas, steam, cable/computer or other special systems. It must include an evaluation of the Proposed Project's impact on the capacity and adequacy of these systems, and whether a need is reasonably attributable to the Proposed Project for upgrading of existing systems.

The analysis must include future projects which may affect the loading of utility systems including the Prudential Center Redevelopment, 222 Berkeley Street, and 116 Huntington Avenue.

If any storm drainage is handled by a combined sewage line, then any circumstances which might result in surcharge or capacity problems in such combined sewage line must be described and mitigated. Analysis of the feasibility of installing separate storm water and sanitary sewerage systems in the lines serving the project and adjacent boundaries on Commercial Street is required in the DPIR.

Any relocations or impacts upon existing systems, including the Green line tunnel, and associated infrastructure systems must be described. A discussion of any floor and roof drains which incorporate oil traps must be included in the DPIR.

Measures to conserve resources including any provisions for recycling, energy conservation and water conservation must be identified.

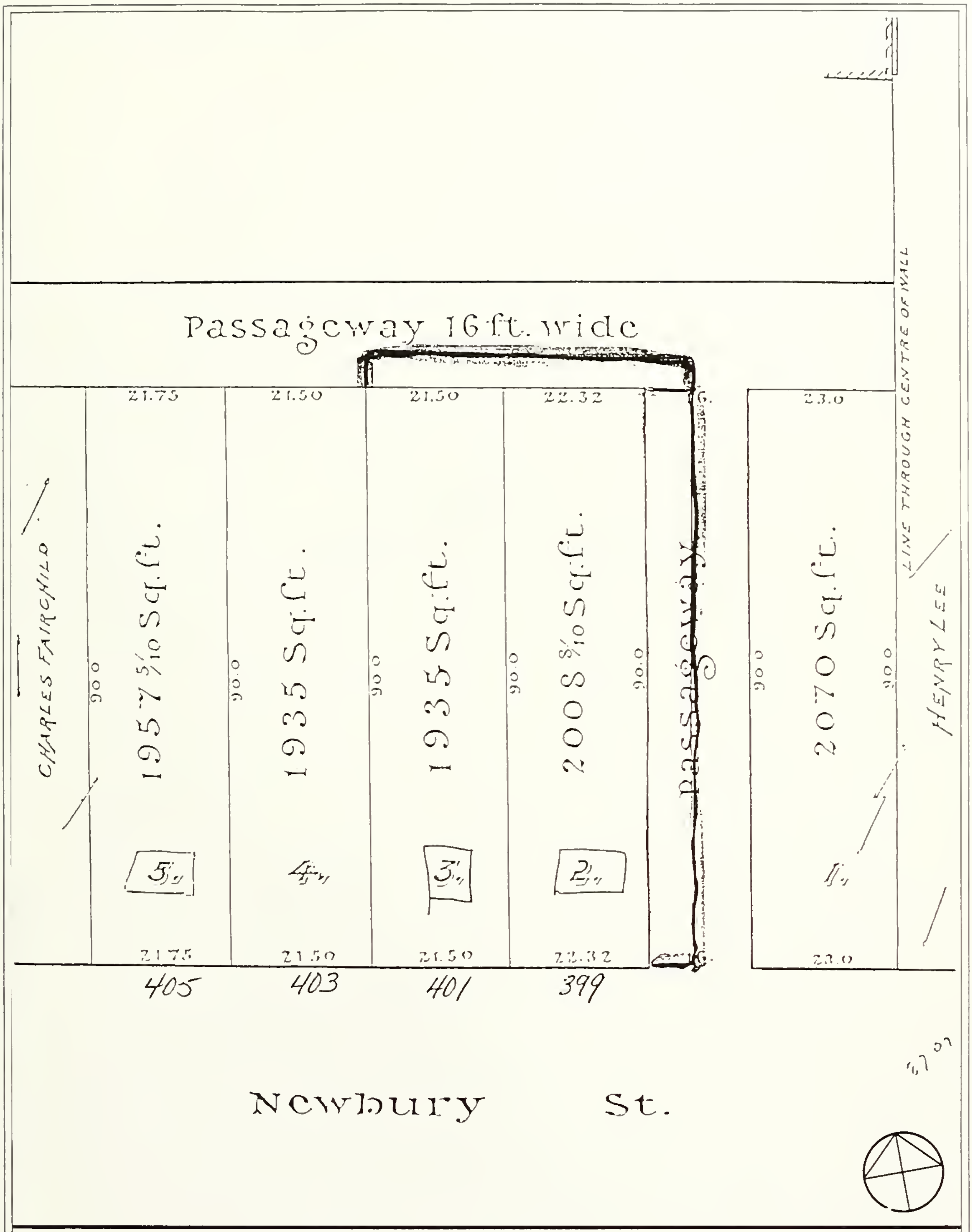
VII. AGREEMENTS

The following must be provided in form and content satisfactory to the appropriate signatory public agencies before the Proposed Project can receive final approval. They are not required for the DPIR.

1. A Cooperation Agreement, pursuant to Section 31-14 of the Code, to provide for monitoring of continued compliance with the Final Project Impact Report, including, but not limited to, a Transportation Access Plan Agreement and Construction Management Plan Agreement.

APPENDIX B

EASEMENTS


Passageway 16 ft. wide
21.75
21.50
21.50
22.32
23.0
CHARLES FAIRCHILD
90.0
1957 5/10 Sq. ft.
5
1935 Sq. ft.
4
1935 Sq. ft.
3
2008 8/10 Sq. ft.
2
Passageway
2070 Sq. ft.
1
LINE THROUGH CENTRE OF WALL
HENRY LEE
21.75
21.50
21.50
22.32
23.0
405
403
401
399
Newbury St.

APPENDIX B

APPENDIX C

DESCRIPTION OF PROJECT AREA

SCHEDULE "A" DESCRIPTION

Those ten (10) certain parcels of land situated in Boston, in the County of Suffolk and Commonwealth of Massachusetts, being both registered and unregistered, all as bounded and described as follows:

PARCEL I - 399 Newbury Street, Boston, Massachusetts

Lot 2 on plan made by W.H. Whitney dated June 6, 1889, and recorded with Suffolk County Registry of Deeds in Book 1885, Page 454.

The land in Boston with the building thereon situated on the northerly side of Newbury Street, being No. 399 on said street, containing two thousand eight and 8/100 (2008.8) square feet more or less being Lot 2 on a plan made by W.H. Whitney dated June 6, 1889, and recorded with Suffolk Deeds Book 1885, Page 454, together with all my rights in the adjoining passageways and bounded and described as follows: - Southerly by Newbury Street twenty-two and 32/100 (22.32) feet; westerly by lot 3 on said plan by a line through the middle of a brick partition-wall ninety (90) feet.

For title reference see deed recorded in Book 4947, Page 314.

PARCEL II - 401 Newbury Street, Boston, Massachusetts

That certain parcel of land situated in Boston, Suffolk County, as filed and registered with the Suffolk County District of the Land Court, bounded and described as follows:

SOUTHERLY	by the northerly line of Newbury Street, twenty-one and 50/100 (21.50) feet;
WESTERLY	by land now or formerly of Emma F. McConnell, the line running in part through the middle of the partition wall, ninety (90) feet;
NORTHERLY	by the southerly line of a passageway sixteen feet wide, twenty-one and 50/100 (21.50) feet; and
EASTERLY	by land now or formerly of Charles R. Batt, Trustee, the line running in part through the middle of the partition wall, ninety (90) feet;

All of said boundaries, except the street line, are determined by the Court to be located as shown on a plan drawn by William E. Hannan, Surveyor, dated November 22, 1905, as approved by the Court, filed in the Land Registration Office as plan No. 1257-A, a copy of a portion of which is filed with certificate of title No. 1021.

There is appurtenant to the above described land a right of way over, and a right of drainage under, the passageways as shown on said plan, as set forth in deed given by S. Horatio Whitwell to Thomas R. White, dated June 29, 1889, recorded with Suffolk Deeds, Book 1885, Page 456.

For title reference see Certificate of Title No. 22876 filed with Suffolk County District of the Land Court.

PARCEL III - 403 Newbury Street, Boston, Massachusetts

> Lot 4 on plan made by W.H. Whitney dated June 6, 1889, and recorded with Suffolk County Registry of Deeds in Book 1885, Page 454.

A certain parcel of land situated in Boston, in the County of Suffolk and said Commonwealth with the buildings numbered 403 Newbury Street thereon, bounded: Southerly in front by said Newbury Street, twenty-one and 50/100 feet; Easterly by Lot 3 on a plan made by William H. Whitney, dated June 6th, 1889, recorded with Suffolk Deeds Book 1885, Page 454, by a line running through the middle of a brick partition wall, ninety feet; Northerly by a passageway six feet wide, twenty-one and 50/100 feet and Westerly by Lot 5 on said plan by a line running in part through the middle of the brick partition wall, ninety feet.

For title reference see deed recorded in Book 5940, Page 412.

PARCEL IV - 405 Newbury Street, Boston, Massachusetts

> Lot 5 on plan made by W.H. Whitney dated June 6, 1889, and recorded with Suffolk County Registry of Deeds in Book 1885, Page 454.

A certain parcel of land with the buildings thereon situated in said Boston, on the Northerly side of Newbury Street and numbered 405 on said Street, being shown as Lot 5 on a plan by William H. Witney, dated June 6, 1889, recorded with Suffolk County Deeds, Book 1885, Page 454, together with a strip of land six (6) inches wide adjacent to said lot on the West and bounded and described as follows:

SOUTHERLY: By Newbury Street, twenty-two and 25/100 (22.25) feet;

EASTERLY: by lot No. 4 on said plan by a line running through the middle of a brick partition wall, ninety (90) feet;

NORTHERLY: by the Southerly side line of a sixteen (16) passageway, twenty-two and 25/100 (22.25) feet; and

WESTERLY: by land now or formerly of Charles Fairchild by a line running through the middle of a brick partition wall ninety (90) feet.

Containing 2002.5 square feet of land, more or less.

For title reference see deed recorded in Book 6931, Page 381.

PARCEL V - 415 Newbury Street, Boston, Massachusetts

A certain parcel of land with the buildings thereon situated and now numbered 415 on Newbury Street, in Boston, Suffolk County, Massachusetts, bounded and described as follows: -

SOUTHERLY by Newbury Street, 131-1/2 feet;

WESTERLY by land formerly of Lawrence Minot, et als, Trustees, and now or late of Louis Berry et al, by a straight line 200 feet distant Easterly from and parallel with the Easterly line of a passageway 16 feet wide running Northerly from said Newbury Street, as shown on a plan by Fuller & Whitney, dated March 5, 1886, recorded with Suffolk Deeds, Book 1713, Page 201, 90 feet;

NORTHERLY by another passageway 16 feet wide, as shown on said plan, which passageway is always to be kept open its full width for the benefit of abutters thereon for the purpose of light, way, drainage and the like, 131-1/2 feet; and

EASTERLY by land formerly of Thomas R. White and now of said Harvard Club of Boston, 90 feet.

Said parcel contains about 11,835 square feet and is a part of Lot A as shown on said plan.

For title reference see deed in Book 7962, page 654.

PARCEL VI - Rear Passageway

A parcel of land situated in Boston bounded and described as follows: - Beginning at a point at the northwest corner of land now or formerly of Phillips Ketchum known as No. 401 Newbury Street and located as shown on a plan drawn by William E. Hannan, surveyor, dated November 22, 1905, and filed in the Land Registration Office as plan No. 1257-A; thence running northerly by a line at right angles to said Newbury Street eight (8) feet; thence turning and running easterly in a line parallel to said Newbury Street along the middle of a passageway extending east and west as shown on said plan sixteen (16) feet wide fifty-nine and eighty-two hundredths (59.82) feet; thence turning and running southerly eight (8) feet to a point at the intersection of the southerly boundary of said passageway and the easterly boundary of a second passageway extending to said Newbury Street as shown on said plan; thence turning and running westerly in a line parallel to said Newbury Street along the southerly boundary of said former passageway fifty-nine and eighty-two hundredths (59.82) feet to the point of beginning, or however otherwise said parcel of land is bounded and described.

For title reference see deed recorded in Book 4947, Page 313.

PARCEL VII - Westerly Passageway

The following parcel of land situated in Boston, bounded and described as follows: - Beginning at a point on the northerly side of Newbury Street, distant 270.28 feet westerly from the corner of West Chester Park and Newbury Street; thence running northerly by a line at right angles to said Newbury Street and through the middle of a passageway 16 feet wide 90 feet; thence turning and running westerly on another passageway 16 feet wide 8 feet; thence turning and running southerly 90 feet to said Newbury Street; thence turning and running easterly on said Newbury Street 8 feet to the point of beginning, being the westerly half of a passageway leading from Newbury Street shown on the plan made by William H. Whitney, dated February 25, 1889, subject, however, to such rights of way, of drainage, and similar rights, as now exist in other parties. Also all my right, title and interest in the fee of the passageway, part of which adjoins the northerly boundary of the parcel above described, together with all my rights of way, of drainage, or any other rights of any nature I may have in, to and over all of both said passageways, whether or not appurtenant to the parcel above described, meaning to include all of such rights owned by me in the whole of said passageways including the parts not conveyed by this instrument, as well as the parts that are so conveyed.

For title reference see deed recorded in Book 4947, Page 313.

Parcels I, II, III, IV, V, VI and VII are subject to and have the benefit of the following:

1. The provisions of a party wall agreement relating to the wall on the Easterly boundary of the granted premises, between Charles Fairchild and Thomas R. White, dated July 31, 1889, recorded with said Deeds, Book 1891, Page 468;

2. The provisions relating to bay-windows extending out and over said passageways 16 feet wide, as set forth in an instrument entered into by, between and among Henry M. Williams, Trustee, A.L.K. Volkmann and others, dated July 1, 1908, recorded with said Deeds, Book 3518, Page 48, so far as the same are now in force and applicable.

Said premises are also subject to the right to slope or bank the filing where required in connection with the laying out of said Newbury Street as a public way, as set forth in a deed from Henry M. Whitney, Trustee, and others, to the City of Boston, dated July 18, 1883, recorded with said Deeds, Book 1609, Page 130.

PARCEL VII - 374 Commonwealth Avenue, Boston, Massachusetts

That certain parcel of land situated in Boston, as shown on a plan by Aspinwall and Lincoln dated February 26, 1912, bounded and described as follows:

Northerly on said Commonwealth Avenue one hundred feet; Easterly on land of the trustees under the will of Henry Lee by two lines, one measuring one hundred twenty-five feet, the other measuring one hundred eleven 78/100 feet; Southerly on Newbury Street, one hundred sixty-six 47/100 feet; Westerly on land now or formerly of White by the middle line of a passageway sixteen feet wide shown on said plan, ninety feet; Northerly on another passageway sixteen feet wide, shown on said plan thirty-one feet, and Westerly in part on the end of said last mentioned passageway and in part on land now or formerly of Pope by a line in part through the middle of the brick partition wall one hundred forty-one feet, containing twenty-seven thousand seven hundred seventy square feet (27,770). Also all interest in the fee and soil and in the use of both of said passageways. Or however otherwise said premises may be bounded and described and be all or any of said measurements more or less.

For title referenced see deed recorded in Book 3661, Page 246.

Said parcel is subject to and has the benefit of the following:

1. The provisions relating to bay-windows extending out and over said passageways 16 feet wide, as set forth in an instrument recorded with said Deeds in Book 3518, Page 48.

2. The provisions relating to the party wall agreement as set forth in an instrument recorded with said Deeds in Book 3669, Page 261.

3. The provisions relating to the fire escape agreement as set forth in an instrument recorded with said Deeds in Book 4725, Page 268.

4. The provisions relating to the license agreement regarding fire escapes as set forth in an instrument recorded with said Deeds in Book 7433, Page 224.

PARCEL IX - 380 Commonwealth Avenue, Boston, Massachusetts

A certain parcel of land with the buildings thereon situated on the southerly side of Commonwealth Avenue and bounded northerly on said Commonwealth Avenue thirty and 9/100 (30.09) feet, Easterly on land now or formerly of Pope by a line passing through the middle of a brick party wall one hundred twenty five (125) feet; Southerly on a passageway sixteen (16) feet wide which leads to Newbury Street as shown on the plan hereinafter mentioned twenty-nine and 91/100 (29.91) feet; and Westerly on land now or formerly of Farwell by a line passing through the middle of a brick party wall one hundred twenty-five (125) feet, containing three thousand seven hundred and fifty (3,750) square feet and being shown as Lot B on a plan made by Fuller and Whitney dated December 28, 1885 and recorded with Suffolk Deeds in Book 1707, Page 402 and 403. Also all right, title and interest in the fee and soil in the use of said passageway which said Luvan C. Hyde had at the time of her death. Or however otherwise bounded, measured or described and be any or all of said measurements more or less.

For title reference see deed recorded in Book 4452, Page 229.

PARCEL X - 378 Commonwealth Avenue, Boston, Massachusetts

All that lot of land situated in that part of said Boston called the Back Bay, bounded and described according to a plan drawn by Fuller & Whitney dated July 3, 1884, and recorded with said Suffolk Deeds as follows:

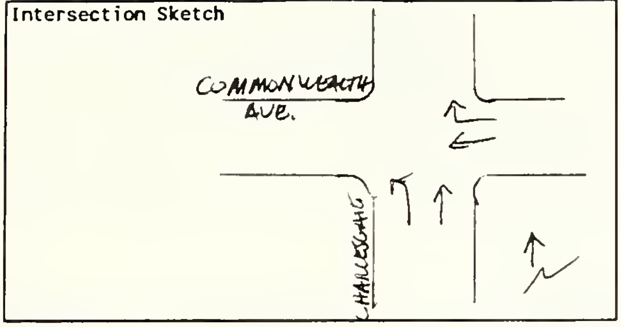
Beginning at a point on the southerly side of Commonwealth Avenue, extended one hundred and sixty-two feet Westerly from the westerly line of Massachusetts Avenue formerly called West Chester Park, and running westerly on said Commonwealth Avenue twenty-nine and 91/00 feet, thence turning at a right angle and running southerly by other land now or formerly of Margaret P. Hinckley through the centre of a brick partition wall one hundred and twenty five feet to a passageway sixteen feet wide, which is always to be kept open for the use of the owners of this and the adjoining lots for the purposes of way drainage and the like thence turning and running easterly on said passageway thirty and 9/100 feet, thence turning and running northerly by other land of Hinckley through the centre of a brick partition wall, one hundred and twenty five feet to the point of beginning, and containing thirty seven hundred and fifty square feet of land, being lot A on said plan; together with fee to the said sixteen foot passageway in the rear in so far as there be any title thereto.

For title reference see deed recorded in Book 5109, Page 321.

APPENDIX D

TRAFFIC VOLUME WORKSHEETS

Intersection Sketch



Project #: 3618
Project Name: HARVARD CLUB
Intersection: COMM. AVE. WB/CHARLESGATE EAST
File: 361811PM
Time Period: PM PEAK
Date of Count: 5/3/90
Counted By: PST
Calc. By: MSP

PEAK HOUR
4:45 PM

Approach 1: CHARLESGATE EAST NB

TIME	LEFT CARS	LEFT TRKS	THRU CARS	THRU TRKS	RIGHT CARS	RIGHT TRKS
4:00 PM	62	1	161	1		
4:15 PM	72	1	181	0		
4:30 PM	52	1	191	2		
4:45 PM	64	0	190	2		
5:00 PM	76	1	210	1		
5:15 PM	70	0	186	2		
5:30 PM	67	0	180	0		
5:45 PM	48	0	169	0		

	LEFT VEH	LEFT %TRK	THRU VEH	THRU %TRK	RIGHT VEH	RIGHT %TRK
	63	2%	162	1%	0	0%
	73	1%	181	0%	0	0%
	53	2%	193	1%	0	0%
	64	0%	192	1%	0	0%
	77	1%	211	0%	0	0%
	70	0%	188	1%	0	0%
	67	0%	180	0%	0	0%
	48	0%	169	0%	0	0%
PEAK HOUR	278	0%	771	1%	0	0%

Approach 2: COMM. AVE. WB

TIME	LEFT CARS	LEFT TRKS	THRU CARS	THRU TRKS	RIGHT CARS	RIGHT TRKS
4:00 PM			108	0	18	0
4:15 PM			121	1	20	0
4:30 PM			121	1	17	0
4:45 PM			147	2	24	0
5:00 PM			180	3	34	0
5:15 PM			160	1	24	0
5:30 PM			149	0	25	0
5:45 PM			132	0	18	0

	LEFT VEH	LEFT %TRK	THRU VEH	THRU %TRK	RIGHT VEH	RIGHT %TRK
	0	0%	108	0%	18	0%
	0	0%	122	1%	20	0%
	0	0%	122	1%	17	0%
	0	0%	149	1%	24	0%
	0	0%	183	2%	34	0%
	0	0%	161	1%	24	0%
	0	0%	149	0%	25	0%
	0	0%	132	0%	18	0%
PEAK HOUR	0	0%	642	1%	107	0%

Approach 3:

TIME	LEFT CARS	LEFT TRKS	THRU CARS	THRU TRKS	RIGHT	RIGHT TRKS
4:00 PM						
4:15 PM						
4:30 PM						
4:45 PM						
5:00 PM						
5:15 PM						
5:30 PM						
5:45 PM						

	LEFT VEH	LEFT %TRK	THRU VEH	THRU %TRK	RIGHT VEH	RIGHT %TRK
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
PEAK HOUR	0	0%	0	0%	0	0%

Approach 4:

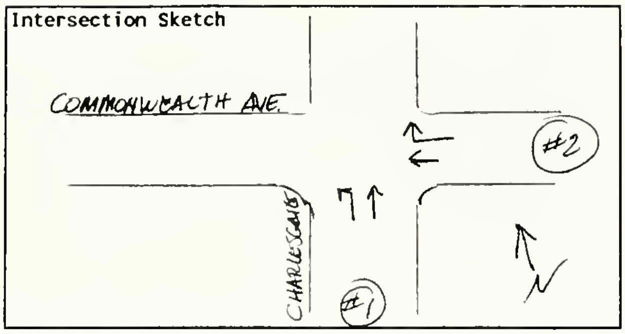
TIME	LEFT CARS	LEFT TRKS	THRU CARS	THRU TRKS	RIGHT CARS	RIGHT TRKS
4:00 PM						
4:15 PM						
4:30 PM						
4:45 PM						
5:00 PM						
5:15 PM						
5:30 PM						
5:45 PM						

	LEFT VEH	LEFT %TRK	THRU VEH	THRU %TRK	RIGHT VEH	RIGHT %TRK
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
PEAK HOUR	0	0%	0	0%	0	0%

TOTAL INTERSECTION VOLUMES

TIME	APP #1 VEH	APP #1 %TRK	APP #1 PHF	APP #2 VEH	APP #2 %TRK	APP #2 PHF	APP #3 VEH	APP #3 %TRK	APP #3 PHF	APP #4 VEH	APP #4 %TRK	APP #4 PHF
4:00 PM	981	1%	0.958	580	1%	0.838	0	0%	0	0	0%	0
4:15 PM	1044	1%	0.9063	671	1%	0.773	0	0%	0	0	0%	0
4:30 PM	1048	1%	0.9097	714	1%	0.823	0	0%	0	0	0%	0
4:45 PM	1049	1%	0.9106	749	1%	0.863	0	0%	0	0	0%	0
5:00 PM	1010	0%	0.8767	726	1%	0.836	0	0%	0	0	0%	0

Intersection Sketch



Project #: 3618
Project Name: HARVARD CLUB
Intersection: COMM. AVE. WB/CHARLESGATE EAST
File: 361811AM
Time Period: AM PEAK
Date of Count: '5/4/90
Counted By: TS
Calc. By: MSP

PEAK HOUR
8:00 AM

Approach 1: CHARLESGATE NB

	LEFT		THRU		RIGHT	
TIME	CARS	TRKS	CARS	TRKS	CARS	TRKS
7:30 AM	23	1	165	2		
7:45 AM	31	2	173	1		
8:00 AM	37	4	153	2		
8:15 AM	40	2	196	4		
8:30 AM	47	1	201	2		
8:45 AM	40	4	203	2		
9:00 AM						
9:15 AM						

	LEFT		THRU		RIGHT	
	VEH	%TRK	VEH	%TRK	VEH	%TRK
	24	4%	167	1%	0	0%
	33	6%	174	1%	0	0%
	41	10%	155	1%	0	0%
	42	5%	200	2%	0	0%
	48	2%	203	1%	0	0%
	44	9%	205	1%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
PEAK HOUR	175	6%	763	1%	0	0%

Approach 2: COMM. AVE. WB

	LEFT		THRU		RIGHT	
TIME	CARS	TRKS	CARS	TRKS	CARS	TRKS
7:30 AM			81	4	13	1
7:45 AM			91	5	14	0
8:00 AM			94	2	16	0
8:15 AM			92	5	19	1
8:30 AM			116	5	25	0
8:45 AM			113	9	21	0
9:00 AM					0	
9:15 AM						

	LEFT		THRU		RIGHT	
	VEH	%TRK	VEH	%TRK	VEH	%TRK
	0	0%	85	5%	14	7%
	0	0%	96	5%	14	0%
	0	0%	96	2%	16	0%
	0	0%	97	5%	20	5%
	0	0%	121	4%	25	0%
	0	0%	122	7%	21	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
PEAK HOUR	0	0%	436	5%	82	1%

Approach 3:

	LEFT		THRU		RIGHT	
TIME	CARS	TRKS	CARS	TRKS		TRKS
7:30 AM						
7:45 AM						
8:00 AM						
8:15 AM						
8:30 AM						
8:45 AM						
9:00 AM						
9:15 AM						

	LEFT		THRU		RIGHT	
	VEH	%TRK	VEH	%TRK	VEH	%TRK
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
PEAK HOUR	0	0%	0	0%	0	0%

Approach 4:

	LEFT		THRU		RIGHT	
TIME	CARS	TRKS	CARS	TRKS	CARS	TRKS
7:30 AM						
7:45 AM						
8:00 AM						
8:15 AM						
8:30 AM						
8:45 AM						
9:00 AM						
9:15 AM						

	LEFT		THRU		RIGHT	
	VEH	%TRK	VEH	%TRK	VEH	%TRK
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
	0	0%	0	0%	0	0%
PEAK HOUR	0	0%	0	0%	0	0%

TOTAL INTERSECTION VOLUMES

	APP #1			APP #2			APP #3			APP #4		
TIME	VEH	%TRK	PHF	VEH	%TRK	PHF	VEH	%TRK	PHF	VEH	%TRK	PHF
7:30 AM	836	2%	0.8636	438	4%	0.936	0	0%	0	0	0%	0
7:45 AM	896	2%	0.8924	485	4%	0.83	0	0%	0	0	0%	0
8:00 AM	938	2%	0.9343	518	4%	0.887	0	0%	0	0	0%	0
8:15 AM	742	2%	0.739	406	5%	0.695	0	0%	0	0	0%	0
8:30 AM	500	2%	0.498	289	5%	0.495	0	0%	0	0	0%	0

```
                              HOWARD/STEIN-HUDSON ASSOCIATES
                                     38 Chauncy Street
                                    Boston, MA  02111

                        VEHICLE TURNING MOVEMENT COUNT SUMMARY:
                                       ALL VEHICLES


INTERSECTION:   Newbury St. &              PROJECT: Harvard Club                      FILE: hcoevaas
                Massachusetts Ave.             DAY: Thursday                                fair
  TOWN/CITY:    Boston, Ma.                   DATE: 12/1/88                                 Leo/Jane
-----------------------------------------------------------------------------------------------------
       STREET  |Mass. Ave.(inbound)   |Newbury St.                |Mass. Ave.(outbound)  | |
     APPROACH  |Southbound            |Westbound                  |Northbound  -         | |
     MOVEMENT  |   TH      R     RR   |  LL     L      S      R   |  LL     L     TH     | | 15 MIN   HOUR
      COUNT #  |    1      2      3   |   4     5      6      7   |   8     9     10   -+| TOTAL    TOTAL
=====================================================================================================


7:00-7:15      |  146     12     12   |  11    14      7      9   |   7     1    180     | |   399
7:15-7:30      |  158     21      3   |  16    16      2      6   |   7     2    185     | |   416
7:30-7:45      |  214     28      6   |  18    22      4      6   |  14     0    220     | |   532
7:45-8:00      |  256     23     10   |  18    24     22      5   |  13     0    185     | |   556    1903
8:00-8:15      |  227     34     25   |  19    42      7      7   |  13     0    187     | |   561    2065
8:15-8:30      |  226     32      8   |  25    23      9     11   |  16     1    206     | |   557    2206
8:30-8:45      |  216     25     17   |  27    23      3     21   |  10     0    193     | |   535    2209
8:45-9:00      |  204     26     17   |  31    23      8      9   |   9     0    170     | |   497    2150

  movement total | 1647  201     98   | 165   187     62     74   |  89     4   1526     | |
  approach total |       1946         |       488                 |      1619            | |  4053

4:00-4:15 PM   |  238     24     28   |  31    46      5     19   |   6     4    269     | |   670
4:15-4:30      |  208     43     16   |  37    32     13     25   |  13     5    182     | |   574
4:30-4:45      |  226     48     18   |  16    23      6     12   |  11     3    215     | |   578
4:45-5:00      |  221     47     21   |  46    50      7     17   |  10     1    224     | |   644    2466
5:00-5:15      |  227     37     30   |  32    33     13     14   |  17     0    188     | |   591    2387
5:15-5:30      |  236     47     23   |  36    37     10     18   |   7     1    227     | |   642    2455
5:30-5:45      |  268     36     37   |  34    46     10     25   |  11     1    215     | |   683    2560
5:45-6:00      |  222     41     35   |  49    43     19     19   |  14     2    202     | |   646    2562

  movement total | 1846  323    208   | 281   310      0    149   |  89    17   1722     | |
  approach total |       2377         |       740                 |      1828            | |  4945

-----------------------------------------------------------------------------------------------------


AM PEAK HOUR PERIOD:      7:45 - 8:45 AM

PM PEAK HOUR PERIOD:      5:00 - 6:00 PM


AM PEAK HOUR:
  movement total |  925   114     60   |  89   112     41     44   |  52     1    771     | |
  approach total |       1099          |       286                 |       824            | |  2209
    approach PHF |       0.95          |       0.95                |       0.92           | |  0.98


PM PEAK HOUR:
  movement total |  953   161    125   | 151   159     52     76   |  49     4    832     | |
  approach total |       1239          |       438                 |       885            | |  2562
    approach PHF |       0.91          |       0.84                |       0.94           | |  0.94
```

```
                              HOWARD/STEIN-HUDSON ASSOCIATES
                                     38 Chauncy Street
                                     Boston, MA  02111

                          VEHICLE TURNING MOVEMENT COUNT SUMMARY:
                                       ALL VEHICLES


  INTERSECTION: Commonwealth Ave. &          PROJECT: Harvard Club                              FILE: h
                Charlesgate E.                   DAY: Wednesday & Friday                     WEATHER: c
     TOWN/CITY: Boston. Ma.                     DATE: 11/30 & 12/2/88                       SURVEYOR: J
------------------------------------------------------------------------------------------------------
         STREET  |Commonwealth Ave.     |Down Ramp          |Charlesgate        |               |
       APPROACH  |Eastbound             |Northbound         |Northbound         |               |
       MOVEMENT  |   L      TH      R   |   L     TH     R  |   L     TH     R  |  L    TH    R | 15 MIN
        COUNT #  |   1       2          |          3     4  |          5     6  |  7     8    9 | TOTAL
======================================================================================================

7:00-7:15        |  74     130          |         25    29  |          6     2  |               |   266
7:15-7:30        |  90     175          |         49    22  |          9     3  |               |   348
7:30-7:45        | 150     222          |         37    27  |          7     4  |               |   447
7:45-8:00        | 153     270          |         51    30  |          8     6  |               |   518
8:00-8:15        | 186     330          |         56    33  |         14     6  |               |   625
8:15-8:30        | 165     303          |         66    43  |         14    10  |               |   601
8:30-8:45        | 148     299          |         76    32  |          9     6  |               |   570
8:45-9:00        | 170     341          |         65    34  |         15     8  |               |   633

  movement total | 1136   2070      0   |   0    425   250  |   0     82    45  |  0     0    0 |
  approach total |        3206          |        675        |        127        |        0      |  4008

4:00-4:15 PM     | 159     297          |         89    35  |         14     8  |               |   602
4:15-4:30        | 120     243          |         91    48  |         12     5  |               |   519
4:30-4:45        | 151     275          |         99    34  |         19    11  |               |   589
4:45-5:00        | 146     279          |         69    36  |         21     9  |               |   560
5:00-5:15        | 171     283          |         86    40  |         19    14  |               |   613
5:15-5:30        | 135     374          |         90    42  |         10     7  |               |   658
5:30-5:45        | 163     261          |         70    52  |         21    18  |               |   585
5:45-6:00        | 157     282          |         85    39  |          9    22  |               |   594

  movement total | 1202   2294      0   |   0    679   326  |   0    125    94  |  0     0    0 |
  approach total |        3496          |       1005        |        219        |        0      |  4720

------------------------------------------------------------------------------------------------------


AM PEAK HOUR PERIOD:     8:00 - 9:00 AM

PM PEAK HOUR PERIOD:     5:00 - 6:00 PM


AM PEAK HOUR:
  movement total |  669   1273      0   |   0    263   142  |   0     52    30  |  0     0    0 |
  approach total |        1942          |        405        |         82        |        0      |  2429
    approach PHF |        0.94          |       0.93        |       0.85        |       ERR     |  0.96


PM PEAK HOUR:
  movement total |  626   1200      0   |   0    331   173  |   0     59    61  |  0     0    0 |
  approach total |        1826          |        504        |        120        |        0      |  2450
    approach PHF |        0.90          |       0.95        |       0.77        |       ERR     |  0.93
```

HOWARD/STEIN-HUDSON ASSOCIATES
38 Chauncy Street
Boston, MA 02111

VEHICLE TURNING MOVEMENT COUNT SUMMARY: ALL VEHICLES

INTERSECTION: Commonwealth Ave. & Mass. Ave.
TOWN/CITY: Boston, Ma.
PROJECT: Harvard Club
DAY:
DATE:
FILE: hcmacome
WEATHER:
SURVEYOR:

STREET	Commonwealth Ave.			Massachusetts Ave.			Commonwealth Ave.			Massachusetts Ave.				
APPROACH	Eastbound			Southbound			Westbound			Northbound				
MOVEMENT	L	TH	R	L	TH	R	L	TH	R	L	TH	R	15 MIN	HOUR
COUNT #	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL	TOTAL
7:00-7:15	15	3	38	9	136	4	7	3	9	3	157	7	391	
7:15-7:30	24	3	57	8	156	10	8	2	8	1	186	11	474	
7:30-7:45	21	6	74	12	169	12	13	4	11	0	189	17	528	
7:45-8:00	21	9	66	9	214	5	32	4	16	0	203	16	595	1988
8:00-8:15	23	5	91	24	211	6	21	7	10	3	174	14	589	2186
8:15-8:30	33	4	71	26	196	18	16	17	18	1	158	13	571	2283
8:30-8:45	31	6	76	25	253	17	20	14	11	1	204	15	673	2428
8:45-9:00	31	5	68	20	188	6	19	8	19	3	168	11	546	2379
movement total	199	41	541	133	1523	78	136	59	102	12	1439	104		
approach total		781			1734			297			1555		4367	
4:00-4:15 PM	16	26	66	14	160	1	11	4	29	3	118	8	456	
4:15-4:30	17	11	27	7	80	2	9	27	15	1	84	6	286	
4:30-4:45	11	13	71	6	134	0	14	28	18	3	85	10	393	
4:45-5:00	5	17	26	14	94	5	9	8	9	6	98	10	301	1436
5:00-5:15	19	16	68	24	161	6	17	36	12	0	59	17	435	1415
5:15-5:30	27	13	83	5	102	2	18	39	8	2	55	9	363	1492
5:30-5:45	25	8	48	17	123	4	11	21	7	4	106	14	388	1487
5:45-6:00	12	10	54	18	171	4	15	29	6	2	67	13	401	1587
movement total	132	114	443	105	1025	24	104	192	104	21	672	87		
approach total		689			1154			400			780		3023	

AM PEAK HOUR PERIOD: 7:45 - 8:45 AM

PM PEAK HOUR PERIOD: 5:00 - 6:00 PM

AM PEAK HOUR:	L	TH	R	L	TH	R	L	TH	R	L	TH	R	
movement total	108	24	304	84	874	46	89	42	55	5	739	58	
approach total		436			1004			186			802		2428
approach PHF		0.92			0.85			0.89			0.91		0.90

PM PEAK HOUR:	L	TH	R	L	TH	R	L	TH	R	L	TH	R	
movement total	83	47	253	64	557	16	61	125	33	8	287	53	
approach total		383			637			219			348		1587
approach PHF		0.78			0.83			0.84			0.70		0.91

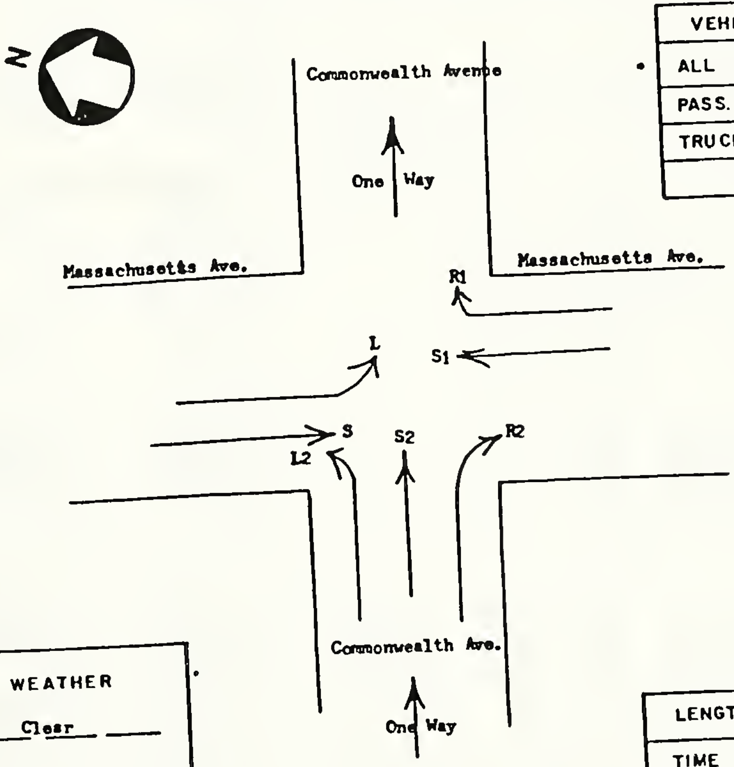
neering, Construction
Mo. Tel. (617) 782-9757

: NO. 343

CITY Boston Proper
INTERSECTION Commonwealth Avenue (Inbound)
& Massachusetts Avenue
DATE 1/28/81 DAY OF WEEK Wednesday

INTERSECTION TURNING MOVEMENT COUNT #70

VEHICLES COUNTED	
ALL	X
PASS. CARS	
TRUCKS	(X)



LENGTH OF COUNT	
TIME	NUMBER OF HOURS
7am-6pm	11 Hours

WEATHER
Clear

COUNT TAKEN BY
D.B., G.W., & J.F.

STREET		ENTERING VOLUME	FLOW PERCENT
Massachusetts Ave.	SB	8436	40.0
Massachusetts Ave.	NB	8008	37.9
Commonwealth Ave.	EB	4665	22.1
TOTAL		21109	100%

COMMENTS

---

ffic Control Systems
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Brighton, Ma. Tel. (617) 782-9757

STA. NO
343

AFFIC MOVEMENT SUMMARY TABLE #7

ION Commonwealth Ave. (Inbound) & Mass. Ave. CITY OR TOWN Boston Proper
E 1/28/81 DAY OF WEEK Wednesday WEATHER Clear RECORDER D.B., G.
& J.F.

TIME STARTS __M	Mass. Ave. Southbound			Mass. Ave. Northbound			Comm. Ave. Eastbound						TOTA HALF H TALL
	L	S			S1	R1	L2	S2	R2				
7:00-7:30	17	329			246	18	25	9	69				713
7:30-8:00	22	420			312	12	37	15	125				943
8:00-8:30	37	406			326	29	54	12	135				999
8:30-9:00	58	321			276	24	52	20	126				877
9:00-9:30	73	342			298	30	50	25	150				968
9:30-10:00	31	273			244	24	46	28	136				781
10:00-10:30	36	233			205	27	43	35	124				703
10:30-11:00	28	255			271	27	44	26	103				754
11:00-11:30	47	250			303	40	47	29	109				825
11:30-12:00	55	259			326	33	39	37	132				881
12:00-12:30	50	288			292	41	56	50	128				905
12:30-1:00	36	306			289	34	59	46	129				899
1:00-1:30	36	265			245	45	62	40	116				809
1:30-2:00	29	271			282	43	70	31	132				858
2:00-2:30	43	304			328	38	67	49	139				958
2:30-3:00	33	294			385	39	58	40	123				972
3:00-3:30	47	415			375	37	60	43	121				1098
3:30-4:00	39	421			409	41	59	47	132				1148
4:00-4:30	43	411			431	48	57	40	119				1149
4:30-5:00	49	461			427	44	63	44	142				1232
5:00-5:30	61	506			466	56	61	49	139				1338
5:30-6:00	57	479			491	51	55	39	127				129
6:00-6:30													
6:30-7:00													
7:00-7:30													
7:30-8:00													
8:00-8:30													
8:30-9:00													
9:00-9:30													
9:30-10:00													
10:00-10:30													
10:30-11:00													
TOTAL	927	7509			7227	781	1153	756	2256				GRAND TOTAL
TOTAL OF LS AR	8436			8008			4665						2110

'ol Systems
.neering, Construction & Maintenance
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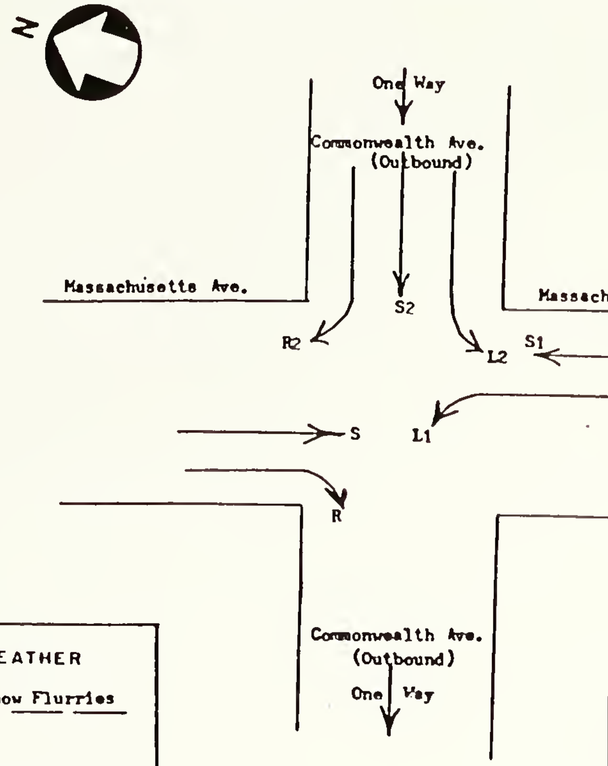
NT. NO. 344

CITY Boston Proper
INTERSECTION Commonwealth Ave. (Outbound) & Massachusetts Ave.
DATE 1/29/81 DAY OF WEEK Thursday

INTERSECTION TURNING MOVEMENT COUNT

#30

VEHICLES COUNTED	
ALL	X
PASS. CARS	
TRUCKS	(X)



WEATHER
Snow Flurries

COUNT TAKEN BY
D.B., G.W., & J.F.

LENGTH OF COUNT	
TIME	NUMBER OF HOURS
7am-6pm	11 Hours

STREET		ENTERING VOLUME	FLOW PERCENT
Mass. Ave.	SB	7872	45.8
Mass. Ave.	NB	7438	43.3
Comm. Ave.	WB	1876	10.9
TOTAL		17186	100%

COMMENTS

'fic Control Systems
Planning, Engineering, Construction, & Maintenance
Brighton, Ma. Tel. (617) 782-9757

STA. NO 344

AFFIC MOVEMENT SUMMARY TABLE

#3

ION Commonwealth Ave. (Outbound) & Mass. Ave. CITY OR TOWN Boston Proper
E 1/29/81 DAY OF WEEK Thursday WEATHER Snow Flurries RECORDER D.B., G.W., J.F

TIME STARTS __M	Mass. Ave. Southbound			Mass. Ave. Northbound			Comm. Ave. Westbound						TOT HALF H TAL
		S	R	L1	S1		L2	S2	R2				
7:00-7:30		329	8	8	282		16	6	4				65
7:30-8:00		467	14	9	367		24	14	20				91
8:00-8:30		407	26	9	303		16	16	13				79
8:30-9:00		414	25	13	326		21	11	32				84
9:00-9:30		349	17	19	299		24	24	23				75
9:30-10:00		278	16	14	221		19	19	25				59
10:00-10:30		274	24	14	238		19	11	19				59
10:30-11:00		247	12	10	225		26	17	24				56
11:00-11:30		261	17	18	234		22	18	23				59
11:30-12:00		265	14	22	266		26	24	30				64
12:00-12:30		284	17	18	262		26	26	25				65
12:30-1:00		255	20	21	259		28	22	34				63
1:00-1:30		272	15	22	275		25	25	43				67
1:30-2:00		255	21	14	262		22	26	30				63
2:00-2:30		277	26	19	306		41	23	26				71
2:30-3:00		293	25	23	330		39	22	23				75
3:00-3:30		368	15	21	412		31	26	34				90
3:30-4:00		375	12	21	398		30	24	28				88
4:00-4:30		401	19	24	408		48	46	45				99
4:30-5:00		427	21	24	429		56	38	47				104
5:00-5:30		483	21	26	501		61	48	83				122
5:30-6:00		465	41	35	431		49	24	66				111
6:00-6:30													
6:30-7:00													
7:00-7:30													
7:30-8:00													
8:00-8:30													
8:30-9:00													
9:00-9:30													
9:30-10:00													
10:00-10:30													
10:30-11:00													
TOTAL		7446	426	404	7034		669	510	697				GRAN TOTA
TOTAL OF L S R	7872			7438			1876						171

APPENDIX E

LOS CALCULATIONS

```
CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
AM EXISTING
date:11-29-1990                 time:15:01:06
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1AMEX     GEOMETRICS=INT1A      SIGNAL=I1AMEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES        # OF LANES      LANE WIDTH      CROSS
DIR  LT    TH    RT     LT  TH  RT       LT    TH    RT     WALK
EB    0     0     0      0   0   0      0.0   0.0   0.0      0
WB    0   475    89      0   2   0      0.0  12.0   0.0      0
NB  210   917     0      1   2   0     11.0  11.0   0.0      0
SB    0     0     0      0   0   0      0.0   0.0   0.0      0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK                PEDESTRIANS         ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%        0     0   .000    0           7.0     0
WB  0.0%  2.0%   N    0     0   .900    0    N      7.0     3
NB  0.0%  2.0%   N    0     0   .900    0    N      7.0     4
SB  0.0%  0.0%        0     0   .000    0           7.0     0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                              51.0   3    P
 2                          *  *                     43.0   3    P

CYCLE= 100.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR   LTV   THV   RTV    PHF   LTFR THFR RTFR
EB      0     0     0  .000      0    0     0
WB      0   475    89  .900      0  528    99
NB    210   917     0  .900    233 1019     0
B       0     0     0  .000      0    0     0

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP   FLOW N    LU      v   Plt   Prt
B  TH-RT       627 2 1.05   658 0.00 0.16
B  LT          233 1 1.00   233 1.00 0.00
B  TH         1019 2 1.05  1070 0.00 0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                 OPPOSING APPROACH
EING OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES      OPPOSING
                 LT    TH    RT       LT    TH    RT       LT  TH  RT     VOLUME
ORTHBOUND         0     0     0        0     0     0        0   0   0        0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP   IDEAL N   Fwid    Fhv    Fgr Fpark  Fbus Farea   Frt    Flt     s
B  TH-RT      1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.976 1.000 3132
B  LT         1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
B  TH         1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

APACITY ANALYSIS WORKSHEET
IR LN GROUP     v     s  v/s  g/C    c  v/c  CRITICAL
```

```
WB  TH-RT      658 3132 0.21 0.51 1597 0.41     *
NB  LT         233 1473 0.16 0.43  633 0.37
NB  TH        1070 3101 0.34 0.43 1333 0.80     *

CYCLE=100.0  LOST= 6.0  SUM V/S CRIT= 0.56 TOTAL V/C= 0.59

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT     0.41 0.51 100.0  11.55 1597    0.10 1.00   11.65  B   8.5
NB  LT        0.37 0.43 100.0  14.67  633    0.17 1.00   14.84  B   3.7
NB  TH        0.80 0.43 100.0  18.85 1333    2.56 0.82   17.62  C  16.1

DIR Delay LOS
WB  11.65  B
NB  17.12  C
INTERSECTION DELAY = 15.29 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  100  TO  100 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 100.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  14.4 SECONDS
for chosen cycle length 100.0
suggested timing phase 1 is  35.6 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  58.4 secs green,   3.0 secs yellow + red clear
```

```
CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
PM EXISTING REVISED GEO
date:11-29-1990             time:15:02:10
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1PMEX     GEOMETRICS=INT1A      SIGNAL=I1PMEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES      # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
EB    0    0    0     0  0  0     0.0  0.0  0.0     0
WB    0   700  117    0  2  0     0.0 12.0  0.0     0
NB  320   887   0     1  2  0    11.0 11.0  0.0     0
SB    0    0    0     0  0  0     0.0  0.0  0.0     0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK             PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%         0    0   .000     0        7.0     0
WB  0.0%  2.0%   N     0    0   .900     0  N     7.0     3
NB  0.0%  2.0%   N     0    0   .900     0  N     7.0     3
SB  0.0%  0.0%         0    0   .000     0        7.0     0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                             52.0   3    P
 2                          *  *                    52.0   3    P

CYCLE= 110.0

VOLUME ADJUSTMENT WORKSHEET
 ART 1 (MOVEMENT ADJUSTMENTS)
 IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
 B     0    0    0  .000     0    0    0
 B     0  700  117  .900     0  778  130
 B   320  887    0  .900   356  986    0
 B     0    0    0  .000     0    0    0

 ART 2 (LANE GROUP ADJUSTMENTS)
 IR LN GROUP  FLOW N   LU    v  Plt  Prt
 B  TH-RT      908 2 1.05  953 0.00 0.14
 B  LT         356 1 1.00  356 1.00 0.00
 B  TH         986 2 1.05 1035 0.00 0.00

 ART 3 (OPPOSING VOLUME ADJUSTMENTS)
 EFT TURN                OPPOSING APPROACH
 CING OPPOSED       VOLUMES      % OPPOSING LEFT TURN   # LANES      OPPOSING
                 LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
  RTHBOUND        0    0    0          0    0    0         0   0   0       0

  TURATION FLOW ADJUSTMENT WORKSHEET
  R LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
    TH-RT     1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.979 1.000 3139
    LT        1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
    TH        1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

  PACITY ANALYSIS WORKSHEET
```

```
DIR LN GROUP    v    s  v/s  g/C    c  v/c   CRITICAL
WB  TH-RT     953 3139 0.30 0.47 1484 0.64     *
NB  LT        356 1473 0.24 0.47  696 0.51
NB  TH       1035 3101 0.33 0.47 1466 0.71     *

CYCLE=110.0  LOST= 6.0  SUM V/S CRIT= 0.64 TOTAL V/C= 0.67

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT    0.64 0.47 110.0  16.69 1484    0.68 1.00   17.37  C  14.6
NB  LT       0.51 0.47 110.0  15.32  696    0.53 1.00   15.85  C   5.7
NB  TH       0.71 0.47 110.0  17.44 1466    1.11 1.00   18.55  C  15.9

DIR Delay LOS
WB  17.37  C
NB  17.86  C
INTERSECTION DELAY = 17.66 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  110  TO  110 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 110.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  18.2 SECONDS
for chosen cycle length 110.0
suggested timing phase 1 is  49.5 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  54.5 secs green,   3.0 secs yellow + red clear
```

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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
SAT EXISTING REVISED GEO
date:11-29-1990             time:15:05:22
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1SATEX    GEOMETRICS=INT1A      SIGNAL=I1SATEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES      # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
EB    0    0    0     0  0  0     0.0  0.0  0.0     0
WB    0  588   98     0  2  0     0.0 12.0  0.0     0
NB  269  745    0     1  2  0    11.0 11.0  0.0     0
SB    0    0    0     0  0  0     0.0  0.0  0.0     0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK             PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%         0    0   .000    0         7.0    0
WB  0.0%  2.0%   N     0    0   .900    0   N     7.0    3
NB  0.0%  2.0%   N     0    0   .900    0   N     7.0    3
SB  0.0%  0.0%         0    0   .000    0         7.0    0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                             40.0    3    P
 2                          *  *                    34.0    3    P

 YCLE=  80.0

 OLUME ADJUSTMENT WORKSHEET
 ART 1 (MOVEMENT ADJUSTMENTS)
 IR   LTV  THV  RTV   PHF  LTFR THFR RTFR
 B     0    0    0  .000     0    0    0
 B     0  588   98  .900     0  653  109
 B   269  745    0  .900   299  828    0
 B     0    0    0  .000     0    0    0

 ART 2 (LANE GROUP ADJUSTMENTS)
 IR LN GROUP  FLOW N   LU     v  Plt  Prt
    TH-RT      762 2 1.05  800 0.00 0.14
    LT         299 1 1.00  299 1.00 0.00
    TH         828 2 1.05  869 0.00 0.00

  RT 3 (OPPOSING VOLUME ADJUSTMENTS)
  FT TURN                OPPOSING APPROACH
  ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN     # LANES     OPPOSING
                 LT   TH   RT        LT   TH   RT        LT  TH  RT     VOLUME
  RTHBOUND        0    0    0         0    0    0        0   0   0        0

  TURATION FLOW ADJUSTMENT WORKSHEET
  R LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt    Flt    s
    TH-RT      1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.979 1.000 3139
    LT         1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
    TH         1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

  PACITY ANALYSIS WORKSHEET
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```
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB   TH-RT     800 3139 0.25 0.50 1570 0.51     *
NB   LT        299 1473 0.20 0.43  626 0.48
NB   TH        869 3101 0.28 0.43 1318 0.66     *

CYCLE= 80.0  LOST= 6.0  SUM V/S CRIT= 0.54 TOTAL V/C= 0.58

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB   TH-RT   0.51 0.50  80.0  10.20 1570    0.24 1.00   10.44  B   8.5
NB   LT      0.48 0.43  80.0  12.61  626    0.46 1.00   13.07  B   3.8
NB   TH      0.66 0.43  80.0  13.97 1318    0.87 1.00   14.84  B  10.6

DIR Delay LOS
WB  10.44  B
NB  14.38  B
INTERSECTION DELAY = 12.78 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  80  TO  80 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  80.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  13.7 SECONDS
for chosen cycle length  80.0
suggested timing phase 1 is  35.2 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  38.8 secs green,   3.0 secs yellow + red clear
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
AM NO BUILD REVISED GEO
date:11-29-1990              time:15:12:05
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1AMNB     GEOMETRICS=INT1A      SIGNAL=I1AMNB
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES        # OF LANES      LANE WIDTH      CROSS
DIR  LT    TH    RT     LT  TH  RT      LT    TH    RT     WALK
EB    0     0     0      0   0   0      0.0   0.0   0.0      0
WB    0   485    91      0   2   0      0.0  12.0   0.0      0
NB  220   959     0      1   2   0     11.0  11.0   0.0      0
SB    0     0     0      0   0   0      0.0   0.0   0.0      0

TRAFFIC & ROADWAY CONDITIONS
                  ADJ PARK                PEDESTRIANS       ARR
DIR GRADE %HV    Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%          0     0  .000     0          7.0     0
WB  0.0%  2.0%    N     0     0  .900     0   N      7.0     3
NB  0.0%  2.0%    N     0     0  .900     0   N      7.0     3
SB  0.0%  0.0%          0     0  .000     0          7.0     0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                            51.0   3    P
 2                          *  *                   43.0   3    P

CYCLE= 100.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR   LTV   THV   RTV   PHF   LTFR  THFR  RTFR
EB      0     0     0  .000      0     0     0
WB      0   485    91  .900      0   539   101
NB    220   959     0  .900    244  1066     0
SB      0     0     0  .000      0     0     0

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP   FLOW N    LU     v   Plt   Prt
B  TH-RT       640 2  1.05   672  0.00  0.16
B  LT          244 1  1.00   244  1.00  0.00
B  TH         1066 2  1.05  1119  0.00  0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                 OPPOSING APPROACH
EING OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES     OPPOSING
                 LT    TH    RT       LT    TH    RT      LT  TH  RT     VOLUME
ORTHBOUND         0     0     0        0     0     0       0   0   0        0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP  IDEAL N  Fwid   Fhv    Fgr   Fpark  Fbus  Farea   Frt    Flt     s
  TH-RT      1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.976 1.000 3132
  LT         1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
  TH         1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

APACITY ANALYSIS WORKSHEET
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```
DIR LN GROUP     v     s  v/s  g/C     c  v/c  CRITICAL
WB  TH-RT      672 3132 0.21 0.51 1597 0.42      *
NB  LT         244 1473 0.17 0.43  633 0.39
NB  TH        1119 3101 0.36 0.43 1333 0.84      *

CYCLE=100.0  LOST= 6.0  SUM V/S CRIT= 0.58 TOTAL V/C= 0.61

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT     0.42 0.51 100.0  11.62 1597    0.11 1.00   11.73  B    8.7
NB  LT        0.39 0.43 100.0  14.80  633    0.20 1.00   15.01  C    3.9
NB  TH        0.84 0.43 100.0  19.32 1333    3.50 1.00   22.81  C   16.9

DIR Delay LOS
WB  11.73  B
NB  21.41  C
INTERSECTION DELAY = 18.22 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  100  TO  100 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 100.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  15.2 SECONDS
for chosen cycle length 100.0
suggested timing phase 1 is  35.1 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  58.9 secs green,   3.0 secs yellow + red clear
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
PM NO BUILD REVISED GEO
date:11-29-1990             time:15:13:19
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1PMNB     GEOMETRICS=INT1A      SIGNAL=I1PMNB
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES      # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
EB     0    0    0     0  0  0     0.0  0.0  0.0      0
WB     0  714  119     0  2  0     0.0 12.0  0.0      0
NB   350  974    0     1  2  0    11.0 11.0  0.0      0
SB     0    0    0     0  0  0     0.0  0.0  0.0      0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK             PEDESTRIANS       ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%         0    0   .000    0         7.0    0
WB  0.0%  2.0%   N     0    0   .900    0   N     7.0    3
NB  0.0%  2.0%   N     0    0   .900    0   N     7.0    3
SB  0.0%  0.0%         0    0   .000    0         7.0    0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                             52.0   3    P
 2                          *  *                    52.0   3    P

CYCLE= 110.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR  LTV  THV  RTV   PHF  LTFR THFR RTFR
 B     0    0    0  .000    0    0    0
 B     0  714  119  .900    0  793  132
 B   350  974    0  .900  389 1082    0
 B     0    0    0  .000    0    0    0

 ART 2 (LANE GROUP ADJUSTMENTS)
 IR LN GROUP   FLOW N   LU     v  Plt  Prt
 B  TH-RT       926 2 1.05  972 0.00 0.14
 B  LT          389 1 1.00  389 1.00 0.00
 B  TH         1082 2 1.05 1136 0.00 0.00

 ART 3 (OPPOSING VOLUME ADJUSTMENTS)
 EFT TURN                OPPOSING APPROACH
 EING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                 LT   TH   RT        LT   TH   RT       LT  TH  RT     VOLUME
 ORTHBOUND        0    0    0         0    0    0        0   0   0        0

 ATURATION FLOW ADJUSTMENT WORKSHEET
 IR LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
 B  TH-RT     1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.979 1.000 3139
 B  LT        1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
 B  TH        1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

 APACITY ANALYSIS WORKSHEET
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```
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  TH-RT     972 3139 0.31 0.47 1484 0.65     *
NB  LT        389 1473 0.26 0.47  696 0.56
NB  TH       1136 3101 0.37 0.47 1466 0.78     *

CYCLE=110.0  LOST= 6.0  SUM V/S CRIT= 0.68 TOTAL V/C= 0.72

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT    0.65 0.47 110.0  16.83 1484    0.75 1.00   17.58  C  14.9
NB  LT       0.56 0.47 110.0  15.79  696    0.77 1.00   16.56  C   6.3
NB  TH       0.78 0.47 110.0  18.34 1466    1.88 1.00   20.22  C  17.4

DIR Delay LOS
WB  17.58  C
NB  19.29  C
INTERSECTION DELAY = 18.62 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  110  TO  110 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 110.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  20.8 SECONDS
for chosen cycle length 110.0
suggested timing phase 1 is  47.6 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  56.4 secs green,   3.0 secs yellow + red clear
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
SAT NB REVISED GEO
date:11-29-1990                 time:15:15:26
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1SATNB    GEOMETRICS=INT1A      SIGNAL=I1SATNB
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
       VOLUMES        # OF LANES      LANE WIDTH      CROSS
DIR  LT    TH    RT     LT TH RT       LT    TH    RT     WALK
EB    0     0     0      0  0  0      0.0   0.0   0.0      0
WB    0   600   100      0  2  0      0.0  12.0   0.0      0
NB  294   818     0      1  2  0     11.0  11.0   0.0      0
SB    0     0     0      0  0  0      0.0   0.0   0.0      0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK                PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%        0     0   .000    0          7.0    0
WB  0.0%  2.0%   N    0     0   .900    0   N      7.0    3
NB  0.0%  2.0%   N    0     0   .900    0   N      7.0    3
SB  0.0%  0.0%        0     0   .000    0          7.0    0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                             40.0   3    P
 2                          *  *                    34.0   3    P

YCLE=  80.0

OLUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
B     0    0    0  .000     0    0    0
B     0  600  100  .900     0  667  111
B   294  818    0  .900   327  909    0
B     0    0    0  .000     0    0    0

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP   FLOW N    LU     v  Plt  Prt
B  TH-RT       778 2 1.05   817 0.00 0.14
B  LT          327 1 1.00   327 1.00 0.00
B  TH          909 2 1.05   954 0.00 0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                OPPOSING APPROACH
EING OPPOSED       VOLUMES       % OPPOSING LEFT TURN      # LANES     OPPOSING
               LT    TH    RT        LT    TH    RT        LT  TH  RT     VOLUME
ORTHBOUND       0     0     0         0     0     0         0   0   0        0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP   IDEAL N   Fwid    Fhv    Fgr  Fpark   Fbus  Farea    Frt    Flt     s
   TH-RT      1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.979 1.000 3139
   LT         1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
   TH         1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

APACITY ANALYSIS WORKSHEET
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```
DIR LN GROUP     v     s  v/s  g/C     c  v/c  CRITICAL
WB  TH-RT      817 3139 0.26 0.50 1570 0.52     *
NB  LT         327 1473 0.22 0.43  626 0.52
NB  TH         954 3101 0.31 0.43 1318 0.72     *

CYCLE= 80.0  LOST= 6.0  SUM V/S CRIT= 0.57 TOTAL V/C= 0.61

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT     0.52 0.50  80.0  10.27 1570   0.26 1.00   10.53  B    8.6
NB  LT        0.52 0.43  80.0  12.92  626   0.65 1.00   13.56  B    4.2
NB  TH        0.72 0.43  80.0  14.52 1318   1.41 1.00   15.93  C   11.6

DIR Delay LOS
WB  10.53  B
NB  15.32  C
INTERSECTION DELAY = 13.46 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  80  TO  80 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  80.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  14.9 SECONDS
for chosen cycle length  80.0
suggested timing phase 1 is  33.9 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  40.1 secs green,   3.0 secs yellow + red clear
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
AM BUILD ALT. #2 REVISED GEO
date:11-29-1990              time:15:16:56
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1AMBDA2   GEOMETRICS=INT1A      SIGNAL=I1AMBDA2
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES       # OF LANES     LANE WIDTH     CROSS
DIR  LT    TH    RT     LT TH RT       LT    TH    RT     WALK
EB    0     0     0      0  0  0      0.0   0.0   0.0      0
WB    0   485    91      0  2  0      0.0  12.0   0.0      0
NB  221   959     0      1  2  0     11.0  11.0   0.0      0
SB    0     0     0      0  0  0      0.0   0.0   0.0      0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK              PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%         0     0   .000    0          7.0    0
WB  0.0%  2.0%   N     0     0   .900    0   N      7.0    3
NB  0.0%  2.0%   N     0     0   .900    0   N      7.0    3
SB  0.0%  0.0%         0     0   .000    0          7.0    0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                                51.0   3    P
 2                          *  *                       43.0   3    P

CYCLE= 100.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
IR   LTV  THV  RTV   PHF   LTFR THFR RTFR
B      0    0    0  .000     0    0    0
B      0  485   91  .900     0  539  101
B    221  959    0  .900   246 1066    0
B      0    0    0  .000     0    0    0

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP   FLOW N    LU     v  Plt  Prt
B  TH-RT       640 2 1.05   672 0.00 0.16
B  LT          246 1 1.00   246 1.00 0.00
B  TH         1066 2 1.05  1119 0.00 0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                 OPPOSING APPROACH
EING OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES      OPPOSING
                 LT    TH    RT       LT    TH    RT       LT  TH  RT     VOLUME
ORTHBOUND         0     0     0        0     0     0        0   0   0        0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP   IDEAL N   Fwid    Fhv    Fgr  Fpark  Fbus  Farea   Frt    Flt     s
B  TH-RT      1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.976 1.000 3132
B  LT         1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
B  TH         1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

APACITY ANALYSIS WORKSHEET
```

```
DIR LN GROUP    v    s  v/s  g/C      c  v/c  CRITICAL
WB  TH-RT     672 3132 0.21 0.51 1597 0.42     *
NB  LT        246 1473 0.17 0.43  633 0.39
NB  TH       1119 3101 0.36 0.43 1333 0.84     *

CYCLE=100.0  LOST= 6.0  SUM V/S CRIT= 0.58 TOTAL V/C= 0.61

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT    0.42 0.51 100.0  11.62 1597    0.11 1.00   11.73  B   8.7
NB  LT       0.39 0.43 100.0  14.82  633    0.21 1.00   15.02  C   3.9
NB  TH       0.84 0.43 100.0  19.32 1333    3.50 1.00   22.81  C  16.9

DIR Delay LOS
WB  11.73  B
NB  21.41  C
INTERSECTION DELAY = 18.22 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  100  TO  100 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 100.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  15.2 SECONDS
for chosen cycle length 100.0
suggested timing phase 1 is  35.1 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  58.9 secs green,   3.0 secs yellow + red clear
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
PM BUILD ALT #2 REVISED GEO
date:11-29-1990            time:15:18:00
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1PMBDA2   GEOMETRICS=INT1A      SIGNAL=I1PMBDA2
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES      # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
EB    0    0    0     0  0  0     0.0  0.0  0.0     0
WB    0  714  119     0  2  0     0.0 12.0  0.0     0
NB  357  974    0     1  2  0    11.0 11.0  0.0     0
SB    0    0    0     0  0  0     0.0  0.0  0.0     0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK             PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%         0    0   .000    0         7.0    0
WB  0.0%  2.0%   N     0    0   .900    0   N     7.0    3
NB  0.0%  2.0%   N     0    0   .900    0   N     7.0    3
SB  0.0%  0.0%         0    0   .000    0         7.0    0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                             52.0   3     P
 2                          *  *                    52.0   3     P

YCLE= 110.0

OLUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
 IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
 B     0    0    0  .000     0    0    0
 B     0  714  119  .900     0  793  132
 B   357  974    0  .900   397 1082    0
 B     0    0    0  .000     0    0    0

 ART 2 (LANE GROUP ADJUSTMENTS)
 IR LN GROUP  FLOW N   LU    v Plt  Prt
    TH-RT      926 2 1.05  972 0.00 0.14
    LT         397 1 1.00  397 1.00 0.00
    TH        1082 2 1.05 1136 0.00 0.00

  RT 3 (OPPOSING VOLUME ADJUSTMENTS)
  FT TURN                OPPOSING APPROACH
  ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                 LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
  RTHBOUND        0    0    0         0    0    0        0   0   0        0

  TURATION FLOW ADJUSTMENT WORKSHEET
  R LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
    TH-RT      1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.979 1.000 3139
    LT         1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
    TH         1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

  PACITY ANALYSIS WORKSHEET
```

```
DIR LN GROUP     v    s  v/s  g/C    c  v/c  CRITICAL
WB  TH-RT      972 3139 0.31 0.47 1484 0.65     *
NB  LT         397 1473 0.27 0.47  696 0.57
NB  TH        1136 3101 0.37 0.47 1466 0.78     *

CYCLE=110.0  LOST= 6.0  SUM V/S CRIT= 0.68 TOTAL V/C= 0.72

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT     0.65 0.47 110.0  16.83 1484    0.75 1.00   17.58  C  14.9
NB  LT        0.57 0.47 110.0  15.90  696    0.84 1.00   16.74  C   6.4
NB  TH        0.78 0.47 110.0  18.34 1466    1.88 1.00   20.22  C  17.4

DIR Delay LOS
WB  17.58  C
NB  19.32  C
INTERSECTION DELAY = 18.65 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  100  TO  110 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 100.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  20.8 SECONDS
for chosen cycle length 100.0
suggested timing phase 1 is  43.0 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  51.0 secs green,   3.0 secs yellow + red clear
```

```
CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
SAT BUILD ALT #2 REVISED GEO
date:11-29-1990              time:15:19:32
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1SABDA2   GEOMETRICS=INT1A      SIGNAL=I1SABDA2
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES        # OF LANES      LANE WIDTH      CROSS
DIR  LT   TH   RT    LT TH  RT     LT   TH   RT     WALK
EB    0    0    0     0  0  0     0.0  0.0  0.0      0
WB    0  600  100     0  2  0     0.0 12.0  0.0      0
NB  296  818    0     1  2  0    11.0 11.0  0.0      0
SB    0    0    0     0  0  0     0.0  0.0  0.0      0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK                PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES   PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%         0     0   .000    0          7.0     0
WB  0.0%  2.0%   N     0     0   .900    0   N      7.0     3
NB  0.0%  2.0%   N     0     0   .900    0   N      7.0     3
SB  0.0%  0.0%         0     0   .000    0          7.0     0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                             40.0   3    P
 2                          *  *                    34.0   3    P

CYCLE=  80.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR  LTV  THV  RTV   PHF  LTFR THFR RTFR
EB     0    0    0  .000    0    0    0
WB     0  600  100  .900    0  667  111
NB   296  818    0  .900  329  909    0
SB     0    0    0  .000    0    0    0

PART 2 (LANE GROUP ADJUSTMENTS)
DIR LN GROUP   FLOW N    LU     v  Plt  Prt
B  TH-RT       778 2 1.05   817 0.00 0.14
B  LT          329 1 1.00   329 1.00 0.00
B  TH          909 2 1.05   954 0.00 0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                OPPOSING APPROACH
EING OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES      OPPOSING
                 LT    TH    RT       LT    TH    RT       LT  TH  RT     VOLUME
ORTHBOUND         0     0     0        0     0     0        0   0   0        0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
B  TH-RT      1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.979 1.000 3139
B  LT         1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
B  TH         1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

APACITY ANALYSIS WORKSHEET
```

```
DIR LN GROUP    v    s  v/s g/C     c  v/c  CRITICAL
WB  TH-RT     817 3139 0.26 0.50 1570 0.52      *
NB  LT        329 1473 0.22 0.43  626 0.53
NB  TH        954 3101 0.31 0.43 1318 0.72      *

CYCLE= 80.0  LOST= 6.0  SUM V/S CRIT= 0.57 TOTAL V/C= 0.61

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT    0.52 0.50  80.0  10.27 1570     0.26 1.00   10.53  B    8.6
NB  LT       0.53 0.43  80.0  12.94  626     0.67 1.00   13.61  B    4.2
NB  TH       0.72 0.43  80.0  14.52 1318     1.41 1.00   15.93  C   11.6

DIR Delay LOS
WB  10.53  B
NB  15.33  C
INTERSECTION DELAY = 13.46 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  80  TO  80 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  80.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  14.9 SECONDS
for chosen cycle length  80.0
suggested timing phase 1 is  33.9 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  40.1 secs green,   3.0 secs yellow + red clear
```

```
CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
AM BUILD ALT #3 REVISED GEO
date:11-29-1990              time:15:30:25
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1AMBDA3   GEOMETRICS=INT1A      SIGNAL=I1AMBDA3
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES       # OF LANES     LANE WIDTH     CROSS
DIR  LT    TH    RT    LT TH RT      LT    TH    RT    WALK
EB    0     0     0     0  0  0     0.0  0.0  0.0      0
WB    0   485    91     0  2  0     0.0 12.0  0.0      0
NB  221   959     0     1  2  0    11.0 11.0  0.0      0
SB    0     0     0     0  0  0     0.0  0.0  0.0      0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK                PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%        0     0   .000    0          7.0     0
WB  0.0%  2.0%   N    0     0   .900    0   N      7.0     3
NB  0.0%  2.0%   N    0     0   .900    0   N      7.0     3
SB  0.0%  0.0%        0     0   .000    0          7.0     0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                             51.0   3    P
 2                          *  *                    43.0   3    P

:YCLE= 100.0

/OLUME ADJUSTMENT WORKSHEET
?ART 1 (MOVEMENT ADJUSTMENTS)
)IR   LTV  THV  RTV   PHF   LTFR THFR RTFR
:B      0    0    0  .000     0    0    0
/B      0  485   91  .900     0  539  101
IB    221  959    0  .900   246 1066    0
;B      0    0    0  .000     0    0    0

'ART 2 (LANE GROUP ADJUSTMENTS)
'IR LN GROUP  FLOW N   LU    v   Plt  Prt
'B  TH-RT      640 2 1.05  672 0.00 0.16
B   LT         246 1 1.00  246 1.00 0.00
B   TH        1066 2 1.05 1119 0.00 0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                OPPOSING APPROACH
EING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                 LT   TH   RT        LT   TH   RT        LT  TH  RT    VOLUME
ORTHBOUND         0    0    0         0    0    0         0   0   0       0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP  IDEAL N  Fwid   Fhv   Fgr  Fpark  Fbus  Farea   Frt    Flt    s
B  TH-RT     1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.976 1.000 3132
B  LT        1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
B  TH        1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

APACITY ANALYSIS WORKSHEET
```

```
DIR LN GROUP     v    s   v/s  g/C    c  v/c  CRITICAL
WB  TH-RT      672 3132 0.21 0.51 1597 0.42     *
NB  LT         246 1473 0.17 0.43  633 0.39
NB  TH        1119 3101 0.36 0.43 1333 0.84     *

CYCLE=100.0  LOST= 6.0  SUM V/S CRIT= 0.58 TOTAL V/C= 0.61

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1     c       d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT    0.42 0.51 100.0  11.62 1597     0.11 1.00   11.73  B   8.7
NB  LT       0.39 0.43 100.0  14.82  633     0.21 1.00   15.02  C   3.9
NB  TH       0.84 0.43 100.0  19.32 1333     3.50 1.00   22.81  C  16.9

DIR Delay LOS
WB  11.73  B
NB  21.41  C
INTERSECTION DELAY = 18.22 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  100  TO  100 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 100.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  15.2 SECONDS
for chosen cycle length 100.0
suggested timing phase 1 is  35.1 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  58.9 secs green,   3.0 secs yellow + red clear
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
PM BUILD ALT #3 REVISED GEO
date:11-29-1990             time:15:31:27
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1PMBDA3   GEOMETRICS=INT1A      SIGNAL=I1PMBDA3
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES       # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT     LT TH RT      LT   TH   RT    WALK
EB    0    0    0      0  0  0     0.0  0.0  0.0     0
WB    0  714  119      0  2  0     0.0 12.0  0.0     0
NB  354  974    0      1  2  0    11.0 11.0  0.0     0
SB    0    0    0      0  0  0     0.0  0.0  0.0     0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK               PEDESTRIANS       ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%         0     0  .000    0           7.0    0
WB  0.0%  2.0%   N     0     0  .900    0   N       7.0    3
NB  0.0%  2.0%   N     0     0  .900    0   N       7.0    3
SB  0.0%  0.0%         0     0  .000    0           7.0    0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                             52.0   3    P
 2                          *  *                    52.0   3    P

CYCLE= 110.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR  LTV  THV  RTV   PHF  LTFR THFR RTFR
EB     0    0    0  .000     0    0    0
WB     0  714  119  .900     0  793  132
NB   354  974    0  .900   393 1082    0
SB     0    0    0  .000     0    0    0

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP   FLOW N    LU     v  Plt  Prt
B  TH-RT       926 2 1.05   972 0.00 0.14
B  LT          393 1 1.00   393 1.00 0.00
B  TH         1082 2 1.05  1136 0.00 0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                 OPPOSING APPROACH
EING OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES     OPPOSING
                 LT   TH   RT         LT   TH   RT       LT  TH  RT     VOLUME
ORTHBOUND         0    0    0          0    0    0        0   0   0        0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
B  TH-RT      1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.979 1.000 3139
B  LT         1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
B  TH         1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

APACITY ANALYSIS WORKSHEET
```

```
DIR LN GROUP    v    s  v/s g/C     c  v/c  CRITICAL
WB  TH-RT     972 3139 0.31 0.47 1484 0.65     *
NB  LT        393 1473 0.27 0.47  696 0.56
NB  TH       1136 3101 0.37 0.47 1466 0.78     *

CYCLE=110.0  LOST= 6.0  SUM V/S CRIT= 0.68 TOTAL V/C= 0.72

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C      d1     c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT    0.65 0.47 110.0  16.83 1484    0.75 1.00   17.58  C  14.9
NB  LT       0.56 0.47 110.0  15.85  696    0.81 1.00   16.66  C   6.3
NB  TH       0.78 0.47 110.0  18.34 1466    1.88 1.00   20.22  C  17.4

DIR Delay LOS
WB  17.58  C
NB  19.31  C
INTERSECTION DELAY = 18.64 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  110  TO  110 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 110.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  20.8 SECONDS
for chosen cycle length 110.0
suggested timing phase 1 is  47.6 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  56.4 secs green,   3.0 secs yellow + red clear
```

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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST/COMM AVE WB
SAT BUILD ALT #3 REVISED GEO
date:11-29-1990              time:15:32:26
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I1SABDA3   GEOMETRICS=INT1A      SIGNAL=I1SABDA3
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES       # OF LANES     LANE WIDTH     CROSS
DIR  LT    TH    RT    LT TH RT      LT    TH    RT    WALK
EB    0     0     0     0  0  0      0.0   0.0   0.0     0
WB    0   600   100     0  2  0      0.0  12.0   0.0     0
NB  298   818     0     1  2  0     11.0  11.0   0.0     0
SB    0     0     0     0  0  0      0.0   0.0   0.0     0

TRAFFIC & ROADWAY CONDITIONS
                  ADJ PARK                PEDESTRIANS       ARR
DIR GRADE %HV    Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%          0     0   .000    0          7.0    0
WB  0.0%  2.0%    N     0     0   .900    0   N      7.0    3
NB  0.0%  2.0%    N     0     0   .900    0   N      7.0    3
SB  0.0%  0.0%          0     0   .000    0          7.0    0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                 *  *                             40.0   3    P
 2                          *  *                    34.0   3    P

CYCLE=  80.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR   LTV  THV  RTV   PHF  LTFR THFR RTFR
EB     0     0    0  .000    0    0    0
WB     0   600  100  .900    0  667  111
NB   298   818    0  .900  331  909    0
SB     0     0    0  .000    0    0    0

PART 2 (LANE GROUP ADJUSTMENTS)
DIR LN GROUP  FLOW N   LU    v   Plt  Prt
WB  TH-RT      778 2 1.05  817 0.00 0.14
NB  LT         331 1 1.00  331 1.00 0.00
NB  TH         909 2 1.05  954 0.00 0.00

PART 3 (OPPOSING VOLUME ADJUSTMENTS)
LEFT TURN                 OPPOSING APPROACH
BEING OPPOSED       VOLUMES       % OPPOSING LEFT TURN     # LANES      OPPOSING
                  LT    TH    RT        LT    TH    RT        LT  TH  RT      VOLUME
NORTHBOUND         0     0     0         0     0     0         0   0   0          0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP   IDEAL N   Fwid    Fhv    Fgr  Fpark  Fbus  Farea    Frt    Flt      s
B  TH-RT      1800  2 1.000 0.990 1.000 1.000 1.000 0.900 0.979 1.000 3139
B  LT         1800  1 0.967 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1473
B  TH         1800  2 0.967 0.990 1.000 1.000 1.000 0.900 1.000 1.000 3101

APACITY ANALYSIS WORKSHEET
```

```
DIR LN GROUP    v     s  v/s  g/C    c  v/c  CRITICAL
WB  TH-RT     817 3139 0.26 0.50 1570 0.52     *
NB  LT        331 1473 0.22 0.43  626 0.53
NB  TH        954 3101 0.31 0.43 1318 0.72     *

CYCLE= 80.0  LOST= 6.0  SUM V/S CRIT= 0.57 TOTAL V/C= 0.61

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  TH-RT    0.52 0.50  80.0  10.27 1570    0.26 1.00   10.53  B   8.6
NB  LT       0.53 0.43  80.0  12.97  626    0.68 1.00   13.65  B   4.2
NB  TH       0.72 0.43  80.0  14.52 1318    1.41 1.00   15.93  C  11.6

DIR Delay LOS
WB  10.53  B
NB  15.34  C
INTERSECTION DELAY = 13.47 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  80  TO  80 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  80.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  14.9 SECONDS
for chosen cycle length  80.0
suggested timing phase 1 is  33.9 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  40.1 secs green,   3.0 secs yellow + red clear
```

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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST @ COMM AVE ~~WB~~ EB
AM EX REVISED GEO
date:11-29-1990             time:15:39:23
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I2AMEX     GEOMETRICS=INT2A      SIGNAL=I2AMEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES       # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH    RT    LT TH RT     LT    TH    RT    WALK
EB  836 1591     0     2  2  0    10.0 10.0   0.0    24
WB    0  242   178     0  1  1     0.0 12.0  12.0    35
NB    0   48    38     0  1  0     0.0 12.0   0.0    35
SB    0    0     0     0  0  0     0.0  0.0   0.0     0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK               PEDESTRIANS       ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  2.0%   Y    10     0   .900    0   Y     15.8    3
WB  0.0%  2.0%   N     0     0   .900    0   Y     15.8    3
NB  0.0%  2.0%   Y    10     0   .900    0   Y     15.8    3
SB  0.0%  0.0%         0     0   .000    0         15.8    0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1  *  *                                            51.0   3    P
 2                 *  *                             28.0   3    P
 3                             *  *                 12.0   3    P

YCLE= 100.0

OLUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR   LTV  THV  RTV   PHF  LTFR THFR RTFR
B    836 1591    0  .900   929 1768    0
B      0  242  178  .900     0  269  198
B      0   48   38  .900     0   53   42
B      0    0    0  .000     0    0    0

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP  FLOW N   LU    v  Plt  Prt
B  LT         929 2 1.05  975 1.00 0.00
B  TH        1768 2 1.05 1856 0.00 0.00
B  TH         269 1 1.00  269 0.00 0.00
B  RT         198 1 1.00  198 0.00 1.00
B  TH-RT       96 1 1.00   96 0.00 0.44

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                OPPOSING APPROACH
EING OPPOSED        VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                 LT   TH   RT      LT    TH    RT      LT  TH  RT     VOLUME
ASTBOUND          0  269  198       0     0     0       0   1   1        0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP  IDEAL N  Fwid   Fhv   Fgr  Fpark  Fbus Farea   Frt   Flt    s
B  LT        1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
B  TH        1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
```

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WB  TH          1800   1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT          1800   1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT       1800   1 1.000 0.990 1.000 0.849 1.000 0.900 0.840 1.000 1144

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT         975 2755 0.35 0.51 1405 0.69
EB  TH        1856 2768 0.67 0.51 1412 1.31     *
WB  TH         269 1604 0.17 0.28  449 0.60     *
WB  RT         198 1363 0.15 0.28  382 0.52
NB  TH-RT       96 1144 0.08 0.12  137 0.70     *

CYCLE=100.0  LOST= 9.0  SUM V/S CRIT= 0.92 TOTAL V/C= 1.01

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT        0.69 0.51 100.0  14.13 1405    1.06 1.00  15.18  C  12.6
EB  TH        1.31 0.51 100.0  27.70 1412  195.17 1.00 222.87  F 121.5
WB  TH        0.60 0.28 100.0  23.67  449    1.60 1.00  25.26  D   5.4
WB  RT        0.52 0.28 100.0  23.04  382    1.02 1.00  24.06  C   4.0
NB  TH-RT     0.70 0.12 100.0  32.11  137    9.42 1.00  41.53  E   2.3

DIR Delay LOS
EB 151.33  F
WB  24.76  C
NB  41.53  E
INTERSECTION DELAY =130.83 INTERSECTION LOS=F

THE CYCLE LENGTH WITHIN THE BOUNDS OF  100  TO  100 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 100.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE 302.3 SECONDS
for chosen cycle length 100.0
suggested timing phase 1 is  66.2 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  16.6 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is   8.2 secs green,   3.0 secs yellow + red clear
```

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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST @ COMM AVE ~~WB~~ EB
PM EX REVISED GEO
date:11-29-1990            time:15:41:53
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I2PMEX     GEOMETRICS=INT2A      SIGNAL=I2PMEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES        # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT     LT TH RT      LT    TH    RT     WALK
EB  744 1500    0      2  2  0     10.0 10.0  0.0     24
WB    0  393  216      0  1  1      0.0 12.0 12.0     35
NB    0   70   76      0  1  0      0.0 12.0  0.0     35
SB    0    0    0      0  0  0      0.0  0.0  0.0      0

TRAFFIC & ROADWAY CONDITIONS
                  ADJ PARK               PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  2.0%   Y    10    0   .900    0   Y     15.8    3
WB  0.0%  2.0%   N     0    0   .900    0   Y     15.8    3
NB  0.0%  2.0%   Y    10    0   .900    0   Y     15.8    3
SB  0.0%  0.0%         0    0   .000    0         15.8    0

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1  *  *                                            52.0   3    P
 2                 *  *                             37.0   3    P
 3                             *  *                 12.0   3    P

CYCLE= 110.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR  LTV  THV  RTV   PHF  LTFR THFR RTFR
EB   744 1500    0  .900   827 1667    0
WB     0  393  216  .900     0  437  240
NB     0   70   76  .900     0   78   84
SB     0    0    0  .000     0    0    0

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP  FLOW N   LU    v  Plt  Prt
B  LT         827 2 1.05  868 1.00 0.00
B  TH        1667 2 1.05 1750 0.00 0.00
B  TH         437 1 1.00  437 0.00 0.00
B  RT         240 1 1.00  240 0.00 1.00
B  TH-RT      162 1 1.00  162 0.00 0.52

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                OPPOSING APPROACH
EING OPPOSED       VOLUMES      % OPPOSING LEFT TURN     # LANES     OPPOSING
                 LT   TH   RT      LT    TH    RT      LT  TH  RT     VOLUME
ASTBOUND          0  437  240       0     0     0       0   1   1        0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
B  LT        1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
B  TH        1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB  TH          1800   1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT          1800   1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT       1800   1 1.000 0.990 1.000 0.849 1.000 0.900 0.830 1.000 1130

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP     v     s  v/s  g/C    c  v/c  CRITICAL
EB  LT         868 2755 0.32 0.47 1302 0.67
EB  TH        1750 2768 0.63 0.47 1309 1.34      *
WB  TH         437 1604 0.27 0.34  540 0.81      *
WB  RT         240 1363 0.18 0.34  459 0.52
NB  TH-RT      162 1130 0.14 0.11  123 1.32      *

CYCLE=110.0  LOST= 9.0  SUM V/S CRIT= 1.05 TOTAL V/C= 1.14

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C      d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT        0.67 0.47 110.0  16.97 1302    0.93 1.00   17.90  C  13.3
EB  TH        1.34 0.47 110.0  31.60 1309  216.05 1.00  247.65  F 128.1
WB  TH        0.81 0.34 110.0  25.30  540    6.24 1.00   31.53  D   8.9
WB  RT        0.52 0.34 110.0  22.34  459    0.89 1.00   23.23  C   4.9
NB  TH-RT     1.32 0.11 110.0  38.74  123  250.64 1.00  289.38  F  15.2

DIR Delay LOS
EB 171.47  F
WB  28.59  D
NB 289.38  F
INTERSECTION DELAY =149.04 INTERSECTION LOS=F

THE CYCLE LENGTH WITHIN THE BOUNDS OF  110  TO  110 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 110.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length 110.0
suggested timing phase 1 is  60.9 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  26.2 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is  13.8 secs green,   3.0 secs yellow + red clear
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NCH PROGRAM VERSION DATE 4-29-1988
85 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ARLESGATE EAST @ COMM AVE ~~WB~~ EB
T EX REVISED GEO
te:11-29-1990             time:15:43:16
ST DATA SET NAMES LOADED OR SAVED
LUME=I2SATEX    GEOMETRICS=INT2A      SIGNAL=I2SATEX
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES       # OF LANES     LANE WIDTH     CROSS
R  LT   TH   RT    LT TH RT      LT   TH   RT     WALK
  625 1261    0     2  2  0    10.0 10.0  0.0     24
    0  330  181     0  1  1     0.0 12.0 12.0     35
    0   59   64     0  1  0     0.0 12.0  0.0     35
    0    0    0     0  0  0     0.0  0.0  0.0      0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK              PEDESTRIANS        ARR
R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
  0.0%  2.0%   Y     10     0   .900    0   Y     15.8    3
  0.0%  2.0%   N      0     0   .900    0   Y     15.8    3
  0.0%  2.0%   Y     10     0   .900    0   Y     15.8    3
  0.0%  0.0%          0     0   .000    0         15.8    0

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
  *  *                                             40.0   3    P
                 *  *                              19.0   3    P
                             *  *                  12.0   3    P

LE=  80.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
   LTV  THV  RTV   PHF  LTFR THFR RTFR
   625 1261    0  .900   694 1401    0
     0  330  181  .900     0  367  201
     0   59   64  .900     0   66   71
     0    0    0  .000     0    0    0

T 2 (LANE GROUP ADJUSTMENTS)
  LN GROUP  FLOW N   LU    v  Plt  Prt
  LT         694 2 1.05  729 1.00 0.00
  TH        1401 2 1.05 1471 0.00 0.00
  TH         367 1 1.00  367 0.00 0.00
  RT         201 1 1.00  201 0.00 1.00
  TH-RT      137 1 1.00  137 0.00 0.52

 T 3 (OPPOSING VOLUME ADJUSTMENTS)
 T TURN                  OPPOSING APPROACH
 NG OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
               LT   TH   RT         LT   TH   RT        LT  TH  RT    VOLUME
 TBOUND         0  367  201          0    0    0         0   1   1       0

 URATION FLOW ADJUSTMENT WORKSHEET
  LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT         1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
  TH         1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB  TH        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT     1800  1 1.000 0.990 1.000 0.849 1.000 0.900 0.830 1.000 1130

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT        729 2755 0.26 0.50 1377 0.53
EB  TH       1471 2768 0.53 0.50 1384 1.06     *
WB  TH        367 1604 0.23 0.24  381 0.96     *
WB  RT        201 1363 0.15 0.24  324 0.62
NB  TH-RT     137 1130 0.12 0.15  169 0.81     *

CYCLE= 80.0  LOST= 9.0  SUM V/S CRIT= 0.88 TOTAL V/C= 0.99

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT       0.53 0.50  80.0  10.34 1377    0.31 1.00   10.65  B    7.7
EB  TH       1.06 0.50  80.0  16.22 1384   37.23 1.00   53.45  E   28.6
WB  TH       0.96 0.24  80.0  22.91  381   26.78 1.00   49.69  E    8.2
WB  RT       0.62 0.24  80.0  20.73  324    2.57 1.00   23.31  C    3.4
NB  TH-RT    0.81 0.15  80.0  24.99  169   16.13 1.00   41.12  E    2.9

DIR Delay LOS
EB  39.27  D
WB  40.34  E
NB  41.12  E
INTERSECTION DELAY = 39.57 INTERSECTION LOS=D

THE CYCLE LENGTH WITHIN THE BOUNDS OF  80  TO  80 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  80.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE 124.0 SECONDS
for chosen cycle length  80.0
suggested timing phase 1 is  42.8 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  18.4 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is   9.7 secs green,   3.0 secs yellow + red clear
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NCH PROGRAM VERSION DATE 4-29-1988
85 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ARLESGATE EAST @ COMM AVE WB
 NO BUILD REVISED GEO
te:11-29-1990             time:15:44:50
ST DATA SET NAMES LOADED OR SAVED
LUME=I2AMNB     GEOMETRICS=INT2A      SIGNAL=I2AMNB
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES      # OF LANES     LANE WIDTH     CROSS
R  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
  879 1623    0     2  2  0    10.0 10.0  0.0     24
    0  247  182     0  1  1     0.0 12.0 12.0     35
    0   53   39     0  1  0     0.0 12.0  0.0     35
    0    0    0     0  0  0     0.0  0.0  0.0      0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK                PEDESTRIANS        ARR
R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
  0.0%  2.0%   Y     10     0   .900     0    Y    15.8     3
  0.0%  2.0%   N      0     0   .900     0    Y    15.8     3
  0.0%  2.0%   Y     10     0   .900     0    Y    15.8     3
  0.0%  0.0%          0     0   .000     0         15.8     0

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
  *  *                                            51.0    3    P
                 *  *                             28.0    3    P
                             *  *                 12.0    3    P

LE= 100.0

UME ADJUSTMENT WORKSHEET
T 1 (MOVEMENT ADJUSTMENTS)
   LTV  THV  RTV   PHF  LTFR THFR RTFR
   879 1623    0  .900   977 1803    0
     0  247  182  .900     0  274  202
     0   53   39  .900     0   59   43
     0    0    0  .000     0    0    0

T 2 (LANE GROUP ADJUSTMENTS)
  LN GROUP  FLOW N   LU     v  Plt  Prt
  LT         977 2 1.05 1026 1.00 0.00
  TH        1803 2 1.05 1894 0.00 0.00
  TH         274 1 1.00  274 0.00 0.00
  RT         202 1 1.00  202 0.00 1.00
  TH-RT      102 1 1.00  102 0.00 0.42

 T 3 (OPPOSING VOLUME ADJUSTMENTS)
 T TURN                  OPPOSING APPROACH
 NG OPPOSED        VOLUMES      % OPPOSING LEFT TURN     # LANES     OPPOSING
               LT   TH   RT         LT    TH    RT        LT  TH  RT    VOLUME
 TBOUND         0  274  202          0     0     0         0   1   1         0

 URATION FLOW ADJUSTMENT WORKSHEET
  LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT        1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
  TH        1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB   TH         1800   1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB   RT         1800   1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB   TH-RT      1800   1 1.000 0.990 1.000 0.849 1.000 0.900 0.843 1.000 1148

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP     v     s  v/s  g/C    c  v/c   CRITICAL
EB   LT       1026 2755 0.37 0.51 1405 0.73
EB   TH       1894 2768 0.68 0.51 1412 1.34      *
WB   TH        274 1604 0.17 0.28  449 0.61      *
WB   RT        202 1363 0.15 0.28  382 0.53
NB   TH-RT     102 1148 0.09 0.12  138 0.74      *

CYCLE=100.0  LOST= 9.0  SUM V/S CRIT= 0.94 TOTAL V/C= 1.04

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C      d1    c      d2    PF   Delay LOS Avg Q  95% Q
EB   LT       0.73 0.51 100.0  14.54 1405    1.38 1.00   15.92  C  13.3
EB   TH       1.34 0.51 100.0  28.88 1412  219.18 1.00  248.06  F 136.5
WB   TH       0.61 0.28 100.0  23.77  449    1.75 1.00   25.51  D   5.5
WB   RT       0.53 0.28 100.0  23.13  382    1.12 1.00   24.25  C   4.0
NB   TH-RT    0.74 0.12 100.0  32.30  138   12.67 1.00   44.98  E   2.5

DIR Delay LOS
EB 166.50  F
WB  24.98  C
NB  44.98  E
INTERSECTION DELAY =143.66 INTERSECTION LOS=F

THE CYCLE LENGTH WITHIN THE BOUNDS OF  100  TO  100 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 100.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE %1484.5 SECONDS
for chosen cycle length 100.0
suggested timing phase 1 is  65.9 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  16.5 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is   8.6 secs green,   3.0 secs yellow + red clear
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NCH PROGRAM VERSION DATE 4-29-1988
85 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ARLESGATE EAST @ COMM AVE ~~WB~~EB
 NO BUILD REVISED GEO
te:11-29-1990             time:15:46:13
ST DATA SET NAMES LOADED OR SAVED
LUME=I2PMNB     GEOMETRICS=INT2A      SIGNAL=I2PMNB
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES      # OF LANES     LANE WIDTH     CROSS
R  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
  839 1546    0     2  2  0    10.0 10.0  0.0    24
    0  401  220     0  1  1     0.0 12.0 12.0    35
    0   84   78     0  1  0     0.0 12.0  0.0    35
    0    0    0     0  0  0     0.0  0.0  0.0     0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK             PEDESTRIANS        ARR
R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
  0.0%  2.0%   Y    10     0  .900    0   Y    15.8    3
  0.0%  2.0%   N     0     0  .900    0   Y    15.8    3
  0.0%  2.0%   Y    10     0  .900    0   Y    15.8    3
  0.0%  0.0%         0     0  .000    0        15.8    0

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
  *  *                                            52.0   3    P
                 *  *                             37.0   3    P
                             *  *                 12.0   3    P

CLE= 110.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R  LTV  THV  RTV   PHF  LTFR THFR RTFR
   839 1546    0  .900   932 1718    0
     0  401  220  .900     0  446  244
     0   84   78  .900     0   93   87
     0    0    0  .000     0    0    0

RT 2 (LANE GROUP ADJUSTMENTS)
  LN GROUP  FLOW N   LU     v  Plt  Prt
  LT         932 2 1.05  979 1.00 0.00
  TH        1718 2 1.05 1804 0.00 0.00
  TH         446 1 1.00  446 0.00 0.00
  RT         244 1 1.00  244 0.00 1.00
  TH-RT      180 1 1.00  180 0.00 0.48

 T 3 (OPPOSING VOLUME ADJUSTMENTS)
 T TURN                OPPOSING APPROACH
 NG OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
               LT   TH  RT         LT   TH   RT       LT  TH  RT    VOLUME
 TBOUND         0  446  244         0    0    0        0   1   1       0

 URATION FLOW ADJUSTMENT WORKSHEET
  LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT        1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
  TH        1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB  TH        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT     1800  1 1.000 0.990 1.000 0.849 1.000 0.900 0.835 1.000 1137

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT         979 2755 0.36 0.47 1302 0.75
EB  TH        1804 2768 0.65 0.47 1309 1.38     *
WB  TH         446 1604 0.28 0.34  540 0.83     *
WB  RT         244 1363 0.18 0.34  459 0.53
NB  TH-RT      180 1137 0.16 0.11  124 1.45     *

CYCLE=110.0  LOST= 9.0  SUM V/S CRIT= 1.09 TOTAL V/C= 1.18

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1    c     d2   PF   Delay LOS Avg Q  95% Q
EB  LT        0.75 0.47 110.0  18.03 1302   1.75 1.00  19.78  C  15.0
EB  TH        1.38 0.47 110.0  33.36 1309 255.88 1.00 289.24  F 151.9
WB  TH        0.83 0.34 110.0  25.49  540   7.08 1.00  32.57  D   9.0
WB  RT        0.53 0.34 110.0  22.43  459   0.96 1.00  23.39  C   5.0
NB  TH-RT     1.45 0.11 110.0  39.42  124 392.01 1.00 431.43  F  24.0

DIR Delay LOS
EB 194.45  F
WB  29.32  D
NB 431.43  F
INTERSECTION DELAY =174.93 INTERSECTION LOS=F

THE CYCLE LENGTH WITHIN THE BOUNDS OF  110  TO  110 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 110.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length 110.0
suggested timing phase 1 is  60.5 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  25.8 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is  14.7 secs green,   3.0 secs yellow + red clear
```

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NCH PROGRAM VERSION DATE 4-29-1988
85 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ARLESGATE EAST @ COMM AVE ~~WB~~ EB
T NO BUILD REVISED GEO
te:11-29-1990                 time:15:47:27
ST DATA SET NAMES LOADED OR SAVED
LUME=I2SATNB    GEOMETRICS=INT2A      SIGNAL=I2SATNB
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES        # OF LANES      LANE WIDTH     CROSS
R  LT   TH    RT     LT TH RT       LT   TH    RT    WALK
  705 1298     0      2  2  0     10.0 10.0  0.0     24
    0  337   185      0  1  1      0.0 12.0 12.0     35
    0   71    65      0  1  0      0.0 12.0  0.0     35
    0    0     0      0  0  0      0.0  0.0  0.0      0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK                PEDESTRIANS         ARR
R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
  0.0%  2.0%   Y     10     0   .900    0   Y     15.8    3
  0.0%  2.0%   N      0     0   .900    0   Y     15.8    3
  0.0%  2.0%   Y     10     0   .900    0   Y     15.8    3
  0.0%  0.0%          0     0   .000    0         15.8    0

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
  *  *                                            40.0   3    P
                 *  *                             19.0   3    P
                             *  *                 12.0   3    P

CLE=  80.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R  LTV  THV  RTV    PHF  LTFR THFR RTFR
   705 1298    0  .900   783 1442    0
     0  337  185  .900     0  374  206
     0   71   65  .900     0   79   72
     0    0    0  .000     0    0    0

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP  FLOW N   LU     v  Plt  Prt
  LT          783 2 1.05  823 1.00 0.00
  TH         1442 2 1.05 1514 0.00 0.00
  TH          374 1 1.00  374 0.00 0.00
  RT          206 1 1.00  206 0.00 1.00
  TH-RT       151 1 1.00  151 0.00 0.48

T 3 (OPPOSING VOLUME ADJUSTMENTS)
T TURN                  OPPOSING APPROACH
NG OPPOSED         VOLUMES       % OPPOSING LEFT TURN     # LANES     OPPOSING
                LT   TH   RT        LT    TH    RT       LT  TH  RT     VOLUME
TBOUND           0  374  206         0     0     0        0   1   1        0

URATION FLOW ADJUSTMENT WORKSHEET
 LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
 LT         1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
 TH         1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB  TH        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT     1800  1 1.000 0.990 1.000 0.849 1.000 0.900 0.835 1.000 1138

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v     s  v/s  g/C    c  v/c  CRITICAL
EB  LT         823 2755 0.30 0.50 1377 0.60
EB  TH        1514 2768 0.55 0.50 1384 1.09     *
WB  TH         374 1604 0.23 0.24  381 0.98     *
WB  RT         206 1363 0.15 0.24  324 0.63
NB  TH-RT      151 1138 0.13 0.15  171 0.89     *

CYCLE= 80.0  LOST= 9.0  SUM V/S CRIT= 0.91 TOTAL V/C= 1.03

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT       0.60 0.50  80.0  10.84 1377    0.53 1.00   11.36  B    8.7
EB  TH       1.09 0.50  80.0  16.78 1384   49.88 1.00   66.67  F   34.7
WB  TH       0.98 0.24  80.0  23.06  381   31.23 1.00   54.29  E    8.8
WB  RT       0.63 0.24  80.0  20.81  324    2.84 1.00   23.65  C    3.5
NB  TH-RT    0.89 0.15  80.0  25.33  171   26.52 1.00   51.85  E    3.6

DIR Delay LOS
EB  47.20  E
WB  43.43  E
NB  51.85  E
INTERSECTION DELAY = 46.72 INTERSECTION LOS=E

THE CYCLE LENGTH WITHIN THE BOUNDS OF  80  TO  80 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  80.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE 233.3 SECONDS
for chosen cycle length  80.0
suggested timing phase 1 is  42.5 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  18.1 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is  10.3 secs green,   3.0 secs yellow + red clear
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
HARLESGATE EAST @ COMM AVE ~~WB~~ EB
M BUILD ALT #2 REVISED GEO
ate:11-29-1990              time:15:48:56
AST DATA SET NAMES LOADED OR SAVED
LUME=I2AMBDA2   GEOMETRICS=INT2A      SIGNAL=I2AMBDA2
CATED IN CBD:Y
LUME & GEOMETRICS
       VOLUMES       # OF LANES     LANE WIDTH     CROSS
R  LT   TH    RT     LT TH RT       LT   TH   RT    WALK
  879 1629     0      2  2  0     10.0 10.0  0.0    24
    0  247   188      0  1  1      0.0 12.0 12.0    35
    0   54    47      0  1  0      0.0 12.0  0.0    35
    0    0     0      0  0  0      0.0  0.0  0.0     0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK            PEDESTRIANS         ARR
R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
  0.0%  2.0%   Y     10     0  .900    0   Y     15.8    3
  0.0%  2.0%   N      0     0  .900    0   Y     15.8    3
  0.0%  2.0%   Y     10     0  .900    0   Y     15.8    3
  0.0%  0.0%          0     0  .000    0         15.8    0

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
  *  *                                            51.0   3    P
                 *  *                             28.0   3    P
                             *  *                 12.0   3    P

CLE= 100.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R  LTV  THV  RTV   PHF  LTFR THFR RTFR
   879 1629    0  .900   977 1810    0
     0  247  188  .900     0  274  209
     0   54   47  .900     0   60   52
     0    0    0  .000     0    0    0

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N    LU    v  Plt  Prt
  LT          977 2 1.05 1026 1.00 0.00
  TH         1810 2 1.05 1900 0.00 0.00
  TH          274 1 1.00  274 0.00 0.00
  RT          209 1 1.00  209 0.00 1.00
  TH-RT       112 1 1.00  112 0.00 0.47

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
T TURN                 OPPOSING APPROACH
NG OPPOSED        VOLUMES        % OPPOSING LEFT TURN     # LANES     OPPOSING
               LT   TH   RT        LT   TH   RT         LT  TH  RT    VOLUME
TBOUND          0  274  209         0    0    0          0   1   1       0

URATION FLOW ADJUSTMENT WORKSHEET
 LN GROUP   IDEAL N  Fwid   Fhv   Fgr  Fpark  Fbus  Farea   Frt   Flt    s
 LT          1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
 TH          1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB  TH          1800  1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT          1800  1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT       1800  1 1.000 0.990 1.000 0.849 1.000 0.900 0.837 1.000 1140

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT        1026 2755 0.37 0.51 1405 0.73
EB  TH        1900 2768 0.69 0.51 1412 1.35     *
WB  TH         274 1604 0.17 0.28  449 0.61     *
WB  RT         209 1363 0.15 0.28  382 0.55
NB  TH-RT      112 1140 0.10 0.12  137 0.82     *

CYCLE=100.0  LOST= 9.0  SUM V/S CRIT= 0.96 TOTAL V/C= 1.05

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1    c      d2    PF   Delay LOS Avg Q  95% Q
EB  LT        0.73 0.51 100.0  14.54 1405     1.38 1.00   15.92  C  13.3
EB  TH        1.35 0.51 100.0  29.11 1412   223.84 1.00  252.96  F 139.5
WB  TH        0.61 0.28 100.0  23.77  449     1.75 1.00   25.51  D   5.5
WB  RT        0.55 0.28 100.0  23.26  382     1.28 1.00   24.54  C   4.2
NB  TH-RT     0.82 0.12 100.0  32.64  137    20.77 1.00   53.41  E   3.0

DIR Delay LOS
EB 169.88  F
WB  25.09  D
NB  53.41  E
INTERSECTION DELAY =146.29 INTERSECTION LOS=F

THE CYCLE LENGTH WITHIN THE BOUNDS OF  100  TO  100 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 100.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length 100.0
suggested timing phase 1 is  65.3 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  16.3 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is   9.4 secs green,   3.0 secs yellow + red clear
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NCH PROGRAM VERSION DATE 4-29-1988
85 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ARLESGATE EAST @ COMM AVE EB
I BD ALT #2 REVISED GEO
te:11-29-1990              time:15:50:28
ST DATA SET NAMES LOADED OR SAVED
LUME=I2PMBDA2   GEOMETRICS=INT2A      SIGNAL=I2PMBDA2
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES      # OF LANES     LANE WIDTH     CROSS
R  LT   TH   RT    LT TH RT     LT    TH    RT    WALK
  839 1546    0     2  2  0    10.0 10.0  0.0     24
    0  401  221     0  1  1     0.0 12.0 12.0     35
    0   91  146     0  1  0     0.0 12.0  0.0     35
    0    0    0     0  0  0     0.0  0.0  0.0      0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK                 PEDESTRIANS        ARR
R GRADE %HV   Y/N MOVES BUSES  PHF  CROSS BUT MIN TIME TYPE
  0.0%  2.0%   Y    10     0   .900    0   Y    15.8     3
  0.0%  2.0%   N     0     0   .900    0   Y    15.8     3
  0.0%  2.0%   Y    10     0   .900    0   Y    15.8     3
  0.0%  0.0%         0     0   .000    0        15.8     0

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
  *  *                                            52.0   3    P
                 *  *                             37.0   3    P
                             *  *                 12.0   3    P

CLE= 110.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R  LTV  THV  RTV   PHF  LTFR THFR RTFR
   839 1546    0  .900   932 1718    0
     0  401  221  .900     0  446  246
     0   91  146  .900     0  101  162
     0    0    0  .000     0    0    0

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N    LU     v  Plt  Prt
  LT          932 2 1.05   979 1.00 0.00
  TH         1718 2 1.05  1804 0.00 0.00
  TH          446 1 1.00   446 0.00 0.00
  RT          246 1 1.00   246 0.00 1.00
  TH-RT       263 1 1.00   263 0.00 0.62

T 3 (OPPOSING VOLUME ADJUSTMENTS)
T TURN                  OPPOSING APPROACH
NG OPPOSED         VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
               LT   TH   RT       LT    TH    RT       LT  TH  RT    VOLUME
TBOUND          0  446  246        0     0     0        0   1   1       0

URATION FLOW ADJUSTMENT WORKSHEET
  LN GROUP   IDEAL N  Fwid   Fhv    Fgr  Fpark  Fbus  Farea   Frt    Flt    s
  LT          1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
  TH          1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB  TH         1800  1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT         1800  1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT      1800  1 1.000 0.990 1.000 0.849 1.000 0.900 0.817 1.000 1112

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP     v    s  v/s  g/C     c  v/c   CRITICAL
EB  LT         979 2755 0.36 0.47 1302 0.75
EB  TH        1804 2768 0.65 0.47 1309 1.38      *
WB  TH         446 1604 0.28 0.34  540 0.83      *
WB  RT         246 1363 0.18 0.34  459 0.54
NB  TH-RT      263 1112 0.24 0.11  121 2.17      *

CYCLE=110.0  LOST= 9.0  SUM V/S CRIT= 1.17 TOTAL V/C= 1.27

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1     c       d2    PF   Delay LOS Avg Q  95% Q
EB  LT        0.75 0.47 110.0  18.03 1302     1.75 1.00   19.78  C  15.0
EB  TH        1.38 0.47 110.0  33.36 1309   255.88 1.00  289.24  F 151.9
WB  TH        0.83 0.34 110.0  25.49  540     7.08 1.00   32.57  D   9.0
WB  RT        0.54 0.34 110.0  22.45  459     0.98 1.00   23.43  C   5.0
NB  TH-RT     2.17 0.11 110.0  43.47  121  2001.52 1.00 2044.98  F 153.2

DIR Delay LOS
EB 194.45  F
WB  29.32  D
NB %2044.98  F
INTERSECTION DELAY =294.31 INTERSECTION LOS=F

THE CYCLE LENGTH WITHIN THE BOUNDS OF  110  TO  110 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 110.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length 110.0
suggested timing phase 1 is  56.4 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  24.1 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is  20.5 secs green,   3.0 secs yellow + red clear
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
HARLESGATE EAST @ COMM AVE EB
AT BUILD ALT #2 REVISED GEO
ate:11-29-1990             time:15:51:53
AST DATA SET NAMES LOADED OR SAVED
OLUME=I2SABDA2   GEOMETRICS=INT2A      SIGNAL=I2SABDA2
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
 R  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
   705 1300    0     2  2  0    10.0 10.0  0.0    24
     0  337  187     0  1  1     0.0 12.0 12.0    35
     0   73   81     0  1  0     0.0 12.0  0.0    35
     0    0    0     0  0  0     0.0  0.0  0.0     0

 AFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
 R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
   0.0%  2.0%   Y    10     0  .900    0   Y    15.8    3
   0.0%  2.0%   N     0     0  .900    0   Y    15.8    3
   0.0%  2.0%   Y    10     0  .900    0   Y    15.8    3
   0.0%  0.0%         0     0  .000    0        15.8    0

 ASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
   *  *                                            40.0   3    P
                  *  *                             19.0   3    P
                              *  *                 12.0   3    P

 CLE=  80.0

 LUME ADJUSTMENT WORKSHEET
 RT 1 (MOVEMENT ADJUSTMENTS)
 R  LTV  THV  RTV   PHF  LTFR THFR RTFR
    705 1300    0  .900   783 1444    0
      0  337  187  .900     0  374  208
      0   73   81  .900     0   81   90
      0    0    0  .000     0    0    0

 RT 2 (LANE GROUP ADJUSTMENTS)
 R LN GROUP  FLOW N   LU    v  Plt  Prt
   LT          783 2 1.05  823 1.00 0.00
   TH         1444 2 1.05 1517 0.00 0.00
   TH          374 1 1.00  374 0.00 0.00
   RT          208 1 1.00  208 0.00 1.00
   TH-RT       171 1 1.00  171 0.00 0.53

 RT 3 (OPPOSING VOLUME ADJUSTMENTS)
  T TURN                OPPOSING APPROACH
  NG OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT     VOLUME
  TBOUND         0  374  208         0    0    0        0   1   1       0

  URATION FLOW ADJUSTMENT WORKSHEET
   LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
   LT        1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
   TH        1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB  TH        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT     1800  1 1.000 0.990 1.000 0.849 1.000 0.900 0.829 1.000 1129

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v     s  v/s  g/C    c  v/c   CRITICAL
EB  LT        823 2755 0.30 0.50 1377 0.60
EB  TH       1517 2768 0.55 0.50 1384 1.10      *
WB  TH        374 1604 0.23 0.24  381 0.98      *
WB  RT        208 1363 0.15 0.24  324 0.64
NB  TH-RT     171 1129 0.15 0.15  169 1.01      *

CYCLE= 80.0  LOST= 9.0  SUM V/S CRIT= 0.93 TOTAL V/C= 1.05

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2    PF   Delay LOS Avg Q  95% Q
EB  LT       0.60 0.50  80.0  10.84 1377    0.53 1.00    11.36  B    8.7
EB  TH       1.10 0.50  80.0  16.81 1384   50.63 1.00    67.44  F   35.1
WB  TH       0.98 0.24  80.0  23.06  381   31.23 1.00    54.29  E    8.8
WB  RT       0.64 0.24  80.0  20.85  324    2.98 1.00    23.83  C    3.5
NB  TH-RT    1.01 0.15  80.0  25.89  169   56.47 1.00    82.36  F    5.5

DIR Delay LOS
EB  47.72  E
WB  43.42  E
NB  82.36  F
INTERSECTION DELAY = 48.83 INTERSECTION LOS=E

THE CYCLE LENGTH WITHIN THE BOUNDS OF  80  TO  80 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  80.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE 501.5 SECONDS
for chosen cycle length  80.0
suggested timing phase 1 is  41.7 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  17.8 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is  11.5 secs green,   3.0 secs yellow + red clear
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
CHARLESGATE EAST @ COMM AVE EB
AM BD ALT #3 REVISED GEO
date:11-29-1990             time:15:53:22
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I2AMBDA3   GEOMETRICS=INT2A      SIGNAL=I2AMBDA3
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES       # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT     LT TH RT       LT   TH   RT    WALK
EB  879 1625    0      2  2  0     10.0 10.0  0.0    24
WB    0  247  184      0  1  1      0.0 12.0 12.0    35
NB    0   54   43      0  1  0      0.0 12.0  0.0    35
SB    0    0    0      0  0  0      0.0  0.0  0.0     0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK                PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  2.0%   Y     10     0   .900    0   Y     15.8    3
B  0.0%  2.0%   N      0     0   .900    0   Y     15.8    3
B  0.0%  2.0%   Y     10     0   .900    0   Y     15.8    3
B  0.0%  0.0%          0     0   .000    0         15.8    0

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
1  *  *                                            51.0   3    P
2                 *  *                             28.0   3    P
3                             *  *                 12.0   3    P

YCLE= 100.0

OLUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR   LTV  THV  RTV   PHF  LTFR THFR RTFR
B   879 1625    0  .900   977 1806    0
B     0  247  184  .900     0  274  204
B     0   54   43  .900     0   60   48
B     0    0    0  .000     0    0    0

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP   FLOW N   LU    v   Plt  Prt
B  LT          977 2 1.05 1026 1.00 0.00
B  TH         1806 2 1.05 1896 0.00 0.00
B  TH          274 1 1.00  274 0.00 0.00
B  RT          204 1 1.00  204 0.00 1.00
B  TH-RT       108 1 1.00  108 0.00 0.44

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                 OPPOSING APPROACH
EING OPPOSED       VOLUMES       % OPPOSING LEFT TURN     # LANES     OPPOSING
                 LT   TH   RT        LT    TH    RT       LT  TH  RT    VOLUME
ASTBOUND          0  274  204         0     0     0        0   1   1       0

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt     s
B  LT          1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
B  TH          1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
```

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WB  TH        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT     1800  1 1.000 0.990 1.000 0.849 1.000 0.900 0.840 1.000 1144

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT       1026 2755 0.37 0.51 1405 0.73
EB  TH       1896 2768 0.68 0.51 1412 1.34     *
WB  TH        274 1604 0.17 0.28  449 0.61     *
WB  RT        204 1363 0.15 0.28  382 0.54
NB  TH-RT     108 1144 0.09 0.12  137 0.79     *

CYCLE=100.0  LOST= 9.0  SUM V/S CRIT= 0.95 TOTAL V/C= 1.04

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT       0.73 0.51 100.0  14.54 1405    1.38 1.00   15.92  C  13.3
EB  TH       1.34 0.51 100.0  28.96 1412  220.73 1.00  249.68  F 137.5
WB  TH       0.61 0.28 100.0  23.77  449    1.75 1.00   25.51  D   5.5
WB  RT       0.54 0.28 100.0  23.17  382    1.17 1.00   24.34  C   4.1
NB  TH-RT    0.79 0.12 100.0  32.49  137   16.64 1.00   49.13  E   2.8

DIR Delay LOS
EB 167.62  F
WB  25.01  D
NB  49.13  E
INTERSECTION DELAY =144.51 INTERSECTION LOS=F

THE CYCLE LENGTH WITHIN THE BOUNDS OF  100  TO  100 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 100.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length 100.0
suggested timing phase 1 is  65.6 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  16.4 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is   9.0 secs green,   3.0 secs yellow + red clear
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NCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
HARLESGATE EAST @ COMM AVE EB
 BUILD ALT #3 REVISED GEO
te:11-29-1990             time:15:54:50
ST DATA SET NAMES LOADED OR SAVED
LUME=I2PMBDA3   GEOMETRICS=INT2A      SIGNAL=I2PMBDA3
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES        # OF LANES      LANE WIDTH      CROSS
R  LT    TH    RT    LT TH RT      LT    TH    RT      WALK
  839 1546     0     2  2  0     10.0 10.0   0.0     24
    0  401   221     0  1  1      0.0 12.0  12.0     35
    0   88   113     0  1  0      0.0 12.0   0.0     35
    0    0     0     0  0  0      0.0  0.0   0.0      0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK                PEDESTRIANS        ARR
R GRADE %HV   Y/N MOVES BUSES  PHF  CROSS BUT MIN TIME TYPE
  0.0%  2.0%   Y    10     0   .900    0   Y     15.8    3
  0.0%  2.0%   N     0     0   .900    0   Y     15.8    3
  0.0%  2.0%   Y    10     0   .900    0   Y     15.8    3
  0.0%  0.0%         0     0   .000    0         15.8    0

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
  *  *                                              52.0   3    P
                 *  *                               37.0   3    P
                             *  *                   12.0   3    P

CLE= 110.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R  LTV  THV  RTV   PHF  LTFR THFR RTFR
   839 1546    0  .900   932 1718    0
     0  401  221  .900     0  446  246
     0   88  113  .900     0   98  126
     0    0    0  .000     0    0    0

RT 2 (LANE GROUP ADJUSTMENTS)
 LN GROUP  FLOW N   LU     v  Plt  Prt
  LT        932 2 1.05   979 1.00 0.00
  TH       1718 2 1.05  1804 0.00 0.00
  TH        446 1 1.00   446 0.00 0.00
  RT        246 1 1.00   246 0.00 1.00
  TH-RT     223 1 1.00   223 0.00 0.56

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
T TURN                 OPPOSING APPROACH
NG OPPOSED        VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
               LT   TH   RT        LT   TH   RT       LT  TH  RT     VOLUME
TBOUND          0  446  246         0    0    0        0   1   1        0

URATION FLOW ADJUSTMENT WORKSHEET
 LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT       1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
  TH       1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB  TH        1800   1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT        1800   1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT     1800   1 1.000 0.990 1.000 0.849 1.000 0.900 0.824 1.000 1122

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP     v     s  v/s  g/C    c  v/c  CRITICAL
EB  LT         979 2755 0.36 0.47 1302 0.75
EB  TH        1804 2768 0.65 0.47 1309 1.38     *
WB  TH         446 1604 0.28 0.34  540 0.83     *
WB  RT         246 1363 0.18 0.34  459 0.54
NB  TH-RT      223 1122 0.20 0.11  122 1.82     *

CYCLE=110.0  LOST= 9.0  SUM V/S CRIT= 1.13 TOTAL V/C= 1.23

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C      d1     c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT        0.75 0.47 110.0  18.03 1302     1.75 1.00   19.78  C  15.0
EB  TH        1.38 0.47 110.0  33.36 1309   255.88 1.00  289.24  F 151.9
WB  TH        0.83 0.34 110.0  25.49  540     7.08 1.00   32.57  D   9.0
WB  RT        0.54 0.34 110.0  22.45  459     0.98 1.00   23.43  C   5.0
NB  TH-RT     1.82 0.11 110.0  41.42  122 1026.07 1.00 1067.49  F  69.3

DIR Delay LOS
EB 194.45  F
WB  29.32  D
NB %1067.49  F
INTERSECTION DELAY =216.32 INTERSECTION LOS=F

THE CYCLE LENGTH WITHIN THE BOUNDS OF  110  TO  110 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 110.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length 110.0
suggested timing phase 1 is  58.3 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  24.9 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is  17.8 secs green,   3.0 secs yellow + red clear
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NCH PROGRAM VERSION DATE 4-29-1988
85 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ARLESGATE EAST @ COMM AVE EB
T BUILD ALT #3 REVISED GEO
te:11-29-1990             time:15:56:15
ST DATA SET NAMES LOADED OR SAVED
LUME=I2SABDA3   GEOMETRICS=INT2A      SIGNAL=I2SABDA3
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES      # OF LANES     LANE WIDTH     CROSS
R  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
  705 1302    0     2  2  0    10.0 10.0  0.0    24
    0  337  189     0  1  1     0.0 12.0 12.0    35
    0   75  106     0  1  0     0.0 12.0  0.0    35
    0    0    0     0  0  0     0.0  0.0  0.0     0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK             PEDESTRIANS       ARR
R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
  0.0%  2.0%   Y    10     0   .900    0   Y    15.8    3
  0.0%  2.0%   N     0     0   .900    0   Y    15.8    3
  0.0%  2.0%   Y    10     0   .900    0   Y    15.8    3
  0.0%  0.0%         0     0   .000    0        15.8    0

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
  *  *                                            40.0   3    P
                 *  *                             19.0   3    P
                             *  *                 12.0   3    P

CLE=  80.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R  LTV  THV  RTV   PHF  LTFR THFR RTFR
   705 1302    0  .900   783 1447    0
     0  337  189  .900     0  374  210
     0   75  106  .900     0   83  118
     0    0    0  .000     0    0    0

RT 2 (LANE GROUP ADJUSTMENTS)
  LN GROUP   FLOW N   LU     v  Plt  Prt
  LT          783 2 1.05  823 1.00 0.00
  TH         1447 2 1.05 1519 0.00 0.00
  TH          374 1 1.00  374 0.00 0.00
  RT          210 1 1.00  210 0.00 1.00
  TH-RT       201 1 1.00  201 0.00 0.59

T 3 (OPPOSING VOLUME ADJUSTMENTS)
 T TURN                OPPOSING APPROACH
 NG OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
               LT   TH  RT         LT   TH   RT        LT  TH  RT    VOLUME
 TBOUND         0  374  210         0    0    0         0   1   1       0

URATION FLOW ADJUSTMENT WORKSHEET
  LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT         1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.920 2755
  TH         1800  2 0.933 0.990 1.000 0.925 1.000 0.900 1.000 1.000 2768
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WB  TH        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 1.000 1.000 1604
WB  RT        1800  1 1.000 0.990 1.000 1.000 1.000 0.900 0.850 1.000 1363
NB  TH-RT     1800  1 1.000 0.990 1.000 0.849 1.000 0.900 0.821 1.000 1118

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT        823 2755 0.30 0.50 1377 0.60
EB  TH       1519 2768 0.55 0.50 1384 1.10      *
WB  TH        374 1604 0.23 0.24  381 0.98      *
WB  RT        210 1363 0.15 0.24  324 0.65
NB  TH-RT     201 1118 0.18 0.15  168 1.20      *

CYCLE= 80.0  LOST= 9.0  SUM V/S CRIT= 0.96 TOTAL V/C= 1.08

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT       0.60 0.50  80.0  10.84 1377    0.53 1.00   11.36  B   8.7
EB  TH       1.10 0.50  80.0  16.84 1384   51.38 1.00   68.22  F  35.5
WB  TH       0.98 0.24  80.0  23.06  381   31.23 1.00   54.29  E   8.8
WB  RT       0.65 0.24  80.0  20.89  324    3.13 1.00   24.02  C   3.6
NB  TH-RT    1.20 0.15  80.0  26.78  168  147.30 1.00  174.08  F  11.6

DIR Delay LOS
EB  48.25  E
WB  43.41  E
NB 174.08  F
INTERSECTION DELAY = 55.44 INTERSECTION LOS=E

THE CYCLE LENGTH WITHIN THE BOUNDS OF  80  TO  80 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  80.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length  80.0
suggested timing phase 1 is  40.5 secs green,   3.0 secs yellow + red clear
suggested timing phase 2 is  17.2 secs green,   3.0 secs yellow + red clear
suggested timing phase 3 is  13.3 secs green,   3.0 secs yellow + red clear
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ NEWBURY ST
M EX
ate:05-23-1990             time:08:34:40
AST DATA SET NAMES LOADED OR SAVED
OLUME=I3AMEX     GEOMETRICS=INT3       SIGNAL=I3AMEX
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B    0    0    0     0  0  0     0.0  0.0  0.0     0
B  111  191   54     1  1  0     9.0  9.0  0.0     0
B   66  954    0     0  2  0     0.0 15.0  0.0     0
B    0 1290  244     0  2  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%          0    0   .000    0         7.0    0
B  0.0%  2.0%   Y     20    0   .900    0   N     7.0    3
B  0.0%  2.0%          0    0   .900    0   N     7.0    4
B  0.0%  2.0%          0    0   .900    0   N     7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
1                          *  *           *  *     55.0   4    A
2              *  *  *                             22.0   4    A

YCLE=  85.0

LUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
B     0    0    0  .000     0    0    0
B   111  191   54  .900   123  212   60
B    66  954    0  .900    73 1060    0
B     0 1290  244  .900     0 1433  271

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP    FLOW N   LU     v  Plt  Prt
B  LT            123 1 1.00  123 1.00 0.00
B  TH-RT         272 1 1.00  272 0.00 0.22
B  LT-TH        1133 2 1.05 1190 0.06 0.00
B  TH-RT        1704 2 1.05 1790 0.00 0.16

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
 FT TURN                OPPOSING APPROACH
 ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
 STBOUND         0    0    0         0    0    0        0   0   0       0
 RTHBOUND        0 1433  271       100  100  100        0   2   0    1399

TURATION FLOW ADJUSTMENT WORKSHEET
 R LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
   LT        1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
   TH-RT     1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.967 1.000 1114
   LT-TH     1800  2 1.100 0.990 1.000 1.000 1.000 0.900 1.000 0.537 1895
   TH-RT     1800  2 0.933 0.990 1.000 1.000 1.000 0.900 0.976 1.000 2923

PPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
PUT VARIABLES
 R  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
   85  55  2 1133 1133   73 0.06  2 1399 0.00
```

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CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 3600 0.389 35.931 0.001 0.852 19.069 0.148  0.348 1800.000 0.074 0.537

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT        123 1371 0.09 0.26  355 0.35
WB  TH-RT     272 1114 0.24 0.26  288 0.94     *
NB  LT-TH    1190 1895 0.63 0.65 1226 0.97     *
SB  TH-RT    1790 2923 0.61 0.65 1891 0.95

CYCLE= 85.0  LOST= 8.0  SUM V/S CRIT= 0.87 TOTAL V/C= 0.96

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP v/c   g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.35 0.26  85.0  19.50  355    0.25 1.00   19.75  C   2.2
WB  TH-RT    0.94 0.26  85.0  23.48  288   27.74 0.85   43.54  E   5.7
NB  LT-TH    0.97 0.65  85.0  10.81 1226   14.14 0.77   19.22  C  10.8
SB  TH-RT    0.95 0.65  85.0  10.38 1891    7.85 0.76   13.91  B  14.2

DIR Delay LOS
WB  36.12  D
NB  19.22  C
SB  13.91  B
INTERSECTION DELAY = 18.38 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  85  TO  85 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  85.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  97.9 SECONDS
for chosen cycle length  85.0
suggested timing phase 1 is  55.4 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  21.6 secs green,   4.0 secs yellow + red clear
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ NEWBURY ST
M EX
ate:05-23-1990             time:08:37:41
AST DATA SET NAMES LOADED OR SAVED
OLUME=I3PMEX     GEOMETRICS=INT3       SIGNAL=I3PMEX
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES       # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B    0     0   0     0  0  0     0.0  0.0  0.0     0
B  189   264  94     1  1  0     9.0  9.0  0.0     0
B   66  1028   0     0  2  0     0.0 15.0  0.0     0
B    0  1227 322     0  2  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%          0    0  .000    0          7.0    0
B  0.0%  2.0%   Y     20    0  .900    0   N      7.0    3
B  0.0%  2.0%          0    0  .900    0   N      7.0    4
B  0.0%  2.0%          0    0  .900    0   N      7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
1                          *  *           *  *     73.0   4    A
2              *  *  *                             37.0   4    A

YCLE= 118.0

LUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
B     0    0    0  .000    0    0    0
B   189  264   94  .900  210  293  104
B    66 1028    0  .900   73 1142    0
B     0 1227  322  .900    0 1363  358

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP    FLOW N   LU     v Plt  Prt
B  LT           210 1 1.00  210 1.00 0.00
B  TH-RT        398 1 1.00  398 0.00 0.26
B  LT-TH       1216 2 1.05 1276 0.06 0.00
B  TH-RT       1721 2 1.05 1807 0.00 0.21

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                 OPPOSING APPROACH
ING OPPOSED        VOLUMES       % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT       LT   TH   RT        LT  TH  RT     VOLUME
STBOUND          0    0    0        0    0    0         0   0   0        0
RTHBOUND         0 1363  358      100  100  100         0   2   0     1399

TURATION FLOW ADJUSTMENT WORKSHEET
 R LN GROUP    IDEAL N   Fwid    Fhv    Fgr Fpark  Fbus Farea   Frt    Flt     s
   LT          1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
   TH-RT       1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.961 1.000 1107
   LT-TH       1800  2 1.100 0.990 1.000 1.000 1.000 0.900 1.000 0.528 1862
   TH-RT       1800  2 0.933 0.990 1.000 1.000 1.000 0.900 0.969 1.000 2901

PPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
PUT VARIABLES
 R  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
  118  73  2 1216 1216   73 0.06  2 1399 0.00
```

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CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 3600 0.389 44.397 0.001 1.000 28.603 0.000  0.000 1800.000 0.055 0.528

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT        210 1371 0.15 0.31  430 0.49
WB  TH-RT     398 1107 0.36 0.31  347 1.15     *
NB  LT-TH    1276 1862 0.69 0.62 1152 1.11     *
SB  TH-RT    1807 2901 0.62 0.62 1795 1.01

CYCLE=118.0  LOST= 8.0  SUM V/S CRIT= 1.05 TOTAL V/C= 1.12

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.49 0.31 118.0  24.95  430    0.72 1.00   25.67  D   4.7
WB  TH-RT    1.15 0.31 118.0  32.99  347   95.25 0.85  109.00  F  16.5
NB  LT-TH    1.11 0.62 118.0  20.74 1152   57.98 0.81   63.76  F  29.1
SB  TH-RT    1.01 0.62 118.0  17.30 1795   17.91 0.78   27.52  D  23.9

DIR Delay LOS
WB  80.21  F
NB  63.76  F
SB  27.52  D
INTERSECTION DELAY = 48.73 INTERSECTION LOS=E

THE CYCLE LENGTH WITHIN THE BOUNDS OF  118  TO  118 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 118.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length 118.0
suggested timing phase 1 is  72.2 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  37.8 secs green,   4.0 secs yellow + red clear
```

```
INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ NEWBURY ST
AT EX
ate:05-23-1990             time:08:40:13
AST DATA SET NAMES LOADED OR SAVED
OLUME=I3SATEX    GEOMETRICS=INT3       SIGNAL=IO3SATEX
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B    0    0    0     0  0  0     0.0  0.0  0.0     0
B  159  222   79     1  1  0     9.0  9.0  0.0     0
B   55  864    0     0  2  0     0.0 15.0  0.0     0
B    0 1031  270     0  2  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK                 PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%         0    0   .000    0         7.0    0
B  0.0%  2.0%   Y    20    0   .900    0   N     7.0    3
B  0.0%  2.0%         0    0   .900    0   N     7.0    4
B  0.0%  2.0%         0    0   .900    0   N     7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *      55.0   4    A
               *  *  *                             29.0   4    A

 CLE=  92.0

 LUME ADJUSTMENT WORKSHEET
 RT 1 (MOVEMENT ADJUSTMENTS)
 R   LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0  .000     0    0    0
    159  222   79  .900   177  247   88
     55  864    0  .900    61  960    0
      0 1031  270  .900     0 1146  300

 RT 2 (LANE GROUP ADJUSTMENTS)
 R LN GROUP   FLOW N   LU     v  Plt  Prt
   LT          177 1 1.00  177 1.00 0.00
   TH-RT       334 1 1.00  334 0.00 0.26
   LT-TH      1021 2 1.05 1072 0.06 0.00
   TH-RT      1446 2 1.05 1518 0.00 0.21

 RT 3 (OPPOSING VOLUME ADJUSTMENTS)
 FT TURN                OPPOSING APPROACH
 ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
 STBOUND         0    0    0         0    0    0        0   0   0       0
 RTHBOUND        0 1146  300       100  100  100        0   2   0    1399

 TURATION FLOW ADJUSTMENT WORKSHEET
 R LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
   LT          1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
   TH-RT       1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.961 1.000 1107
   LT-TH       1800  2 1.100 0.990 1.000 1.000 1.000 0.900 1.000 0.538 1897
   TH-RT       1800  2 0.933 0.990 1.000 1.000 1.000 0.900 0.969 1.000 2901

 PPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
 PUT VARIABLES
 R  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
   92  55  2 1021 1021    61 0.06  2 1399 0.00
```

```
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 3600 0.389 31.482 0.001 0.788 23.518 0.212  0.538 1800.000 0.075 0.538

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT        177 1371 0.13 0.32  432 0.41
WB  TH-RT     334 1107 0.30 0.32  349 0.96     *
NB  LT-TH    1072 1897 0.57 0.60 1134 0.95     *
SB  TH-RT    1518 2901 0.52 0.60 1734 0.88

CYCLE= 92.0  LOST= 8.0  SUM V/S CRIT= 0.87 TOTAL V/C= 0.95

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP v/c  g/C    C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.41 0.32  92.0  18.82  432    0.37 1.00   19.18  C   3.1
WB  TH-RT    0.96 0.32  92.0  23.49  349   27.43 0.85   43.29  E   6.9
NB  LT-TH    0.95 0.60  92.0  13.00 1134   11.31 0.76   18.54  C  10.5
SB  TH-RT    0.88 0.60  92.0  11.86 1734    3.84 0.74   11.60  B  14.9

DIR Delay LOS
WB  34.96  D
NB  18.54  C
SB  11.60  B
INTERSECTION DELAY = 17.85 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  92  TO  92 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  92.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  92.0 SECONDS
for chosen cycle length  92.0
suggested timing phase 1 is  54.7 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  29.3 secs green,   4.0 secs yellow + red clear
```

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 NCH PROGRAM VERSION DATE 4-29-1988
 85 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
 SS AVE @ NEWBURY ST
 NO BUILD W/BTD PROPOSED IMPROVEMENTS
 te:11-29-1990             time:15:58:31
 ST DATA SET NAMES LOADED OR SAVED
 LUME=I3AMNB     GEOMETRICS=INT3BTD    SIGNAL=I3AMNB
 CATED IN CBD:Y
 LUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
 R  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
     0    0    0     0  0  0     0.0  0.0  0.0     0
   118  208   56     1  1  0     9.0  9.0  0.0     0
    69  988    0     0  3  0     0.0 10.0  0.0     0
     0 1482  254     0  3  0     0.0 10.0  0.0     0

 AFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
 R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
   0.0%  0.0%         0    0   .000    0         7.0    0
   0.0%  2.0%   Y    20    0   .900    0   N     7.0    3
   0.0%  2.0%         0    0   .900    0   N     7.0    4
   0.0%  2.0%         0    0   .900    0   N     7.0    4

 ASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *     73.0   4    A
               *  *  *                             30.0   4    A

 LE= 111.0

 LUME ADJUSTMENT WORKSHEET
 RT 1 (MOVEMENT ADJUSTMENTS)
 R  LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0  .000     0    0    0
    118  208   56  .900   131  231   62
     69  988    0  .900    77 1098    0
      0 1482  254  .900     0 1647  282

 RT 2 (LANE GROUP ADJUSTMENTS)
 R LN GROUP  FLOW N   LU    v  Plt Prt
   LT          131 1 1.00  131 1.00 0.00
   TH-RT       293 1 1.00  293 0.00 0.21
   LT-TH      1174 3 1.10 1292 0.07 0.00
   TH-RT      1929 3 1.10 2122 0.00 0.15

  T 3 (OPPOSING VOLUME ADJUSTMENTS)
  T TURN                OPPOSING APPROACH
  NG OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES      OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT     VOLUME
  TBOUND          0    0    0         0    0    0        0   0   0       0
  THBOUND         0 1647  282       100  100  100        0   3   0    1399

  URATION FLOW ADJUSTMENT WORKSHEET
   LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
   LT         1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
   TH-RT      1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.968 1.000 1115
   LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.685 3077
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SB   TH-RT     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 0.978 1.000 4393

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB 111  73  3 1174 1174   77 0.07  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs     Pl     Gq     Pt     Gf        El     Fm   Flt
NB 5400 0.259 59.713 0.001 1.000 13.287 0.000  0.000 1800.000 0.055 0.685

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT        131 1371 0.10 0.27  371 0.35
WB  TH-RT     293 1115 0.26 0.27  301 0.97      *
NB  LT-TH    1292 3077 0.42 0.66 2023 0.64
SB  TH-RT    2122 4393 0.48 0.66 2889 0.73      *

CYCLE=111.0  LOST= 8.0  SUM V/S CRIT= 0.75 TOTAL V/C= 0.80

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.35 0.27 111.0  24.84  371    0.25 1.00   25.09  D    3.0
WB  TH-RT    0.97 0.27 111.0  30.48  301   33.09 0.85   54.03  E    7.7
NB  LT-TH    0.64 0.66 111.0   8.52 2023    0.49 0.64    5.76  B   12.4
SB  TH-RT    0.73 0.66 111.0   9.56 2889    0.70 0.68    7.02  B   20.4

DIR Delay  LOS
WB  45.09   E
NB   5.76   B
SB   7.02   B
INTERSECTION DELAY = 10.81 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  11  TO  111 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 111.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  37.3 SECONDS
for chosen cycle length 111.0
suggested timing phase 1 is  66.7 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  36.3 secs green,   4.0 secs yellow + red clear
```

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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ NEWBURY ST
I NO BUILD W/BTD PROP. IMPS. & SIGNAL OPT.
ite:11-29-1990              time:16:01:28
AST DATA SET NAMES LOADED OR SAVED
LUME=I3PMNB     GEOMETRICS=INT3BTD    SIGNAL=I3PMNBR2
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES         # OF LANES     LANE WIDTH      CROSS
R  LT   TH   RT      LT TH RT       LT   TH   RT     WALK
    0    0    0       0  0  0      0.0  0.0  0.0       0
  220  367  103       1  1  0      9.0  9.0  0.0       0
   68 1091    0       0  3  0      0.0 10.0  0.0       0
    0 1305  336       0  3  0      0.0 10.0  0.0       0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK                 PEDESTRIANS        ARR
R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
  0.0%  0.0%          0     0  .000   0          7.0    0
  0.0%  2.0%   Y     20     0  .900   0    N     7.0    3
  0.0%  2.0%          0     0  .900   0    N     7.0    4
  0.0%  2.0%          0     0  .900   0    N     7.0    4

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                          *  *           *  *     54.5   4    A
              *  *  *                             55.5   4    A

CLE= 118.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R  LTV  THV  RTV   PHF  LTFR THFR RTFR
     0    0    0  .000     0    0    0
   220  367  103  .900   244  408  114
    68 1091    0  .900    76 1212    0
     0 1305  336  .900     0 1450  373

RT 2 (LANE GROUP ADJUSTMENTS)
 LN GROUP   FLOW N   LU    v  Plt  Prt
 LT          244 1 1.00  244 1.00 0.00
 TH-RT       522 1 1.00  522 0.00 0.22
 LT-TH      1288 3 1.10 1417 0.06 0.00
 TH-RT      1823 3 1.10 2006 0.00 0.20

T 3 (OPPOSING VOLUME ADJUSTMENTS)
T TURN                 OPPOSING APPROACH
NG OPPOSED        VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
               LT   TH   RT        LT   TH   RT        LT  TH  RT    VOLUME
TBOUND          0    0    0         0    0    0         0   0   0         0
THBOUND         0 1450  373       100  100  100         0   3   0      1399

URATION FLOW ADJUSTMENT WORKSHEET
 LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
 LT          1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
 TH-RT       1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.967 1.000 1114
 LT-TH       1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.691 3104
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SB  TH-RT     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 0.969 1.000 4353

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB 118  55  3 1288 1288   76 0.06  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.259 32.332 0.001 1.000 22.194 0.000  0.000 1800.000 0.074 0.691

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C     c  v/c  CRITICAL
WB  LT         244 1371 0.18 0.47  645 0.38
WB  TH-RT      522 1114 0.47 0.47  524 1.00     *
NB  LT-TH     1417 3104 0.46 0.46 1434 0.99
SB  TH-RT     2006 4353 0.46 0.46 2012 1.00     *

CYCLE=118.0  LOST= 8.0  SUM V/S CRIT= 0.93 TOTAL V/C= 1.00

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c g/C    C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.38 0.47 118.0  15.32  645    0.19 1.00   15.51  C    4.2
WB  TH-RT    1.00 0.47 118.0  23.70  524   29.52 0.85   45.23  E   11.1
NB  LT-TH    0.99 0.46 118.0  23.86 1434   15.72 0.78   30.70  D   22.7
SB  TH-RT    1.00 0.46 118.0  24.06 2012   14.82 0.78   30.27  D   32.1

DIR Delay LOS
WB  35.76  D
NB  30.70  D
SB  30.27  D
INTERSECTION DELAY = 31.42 INTERSECTION LOS=D

THE CYCLE LENGTH WITHIN THE BOUNDS OF  118  TO  118 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 118.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE 370.4 SECONDS
THE EXISTING TIMING IS OPTIMAL
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NCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
SS AVE @ NEWBURY ST
T NO BUILD W/BTD PROPOSED IMPS. & SIGNAL OPT
te:11-29-1990             time:16:03:34
ST DATA SET NAMES LOADED OR SAVED
LUME=I3SATNB    GEOMETRICS=INT3BTD    SIGNAL=I3SANBR2
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES       # OF LANES      LANE WIDTH      CROSS
R  LT    TH    RT     LT TH RT      LT    TH    RT     WALK
    0     0     0     0  0  0     0.0   0.0   0.0      0
  184   285    87     1  1  0     9.0   9.0   0.0      0
   57   918     0     0  3  0     0.0  10.0   0.0      0
    0  1100   281     0  3  0     0.0  10.0   0.0      0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK                PEDESTRIANS        ARR
R GRADE %HV    Y/N MOVES BUSES   PHF CROSS BUT MIN TIME TYPE
  0.0%  0.0%           0     0  .000     0          7.0    0
  0.0%  2.0%    Y     20     0  .900     0   N      7.0    3
  0.0%  2.0%           0     0  .900     0   N      7.0    4
  0.0%  2.0%           0     0  .900     0   N      7.0    4

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                          *  *              *  *    53.6   4    A
              *  *  *                               51.4   4    A

CLE= 113.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R  LTV  THV  RTV   PHF  LTFR THFR RTFR
     0    0    0  .000     0    0    0
   184  285   87  .900   204  317   97
    57  918    0  .900    63 1020    0
     0 1100  281  .900     0 1222  312

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP  FLOW N   LU    v  Plt  Prt
  LT         204 1 1.00  204 1.00 0.00
  TH-RT      413 1 1.00  413 0.00 0.23
  LT-TH     1083 3 1.10 1192 0.06 0.00
  TH-RT     1534 3 1.10 1688 0.00 0.20

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
T TURN                  OPPOSING APPROACH
NG OPPOSED        VOLUMES     % OPPOSING LEFT TURN     # LANES      OPPOSING
               LT   TH   RT       LT   TH   RT       LT  TH  RT      VOLUME
TBOUND          0    0    0        0    0    0        0   0   0           0
THBOUND         0 1222  312      100  100  100        0   3   0        1399

URATION FLOW ADJUSTMENT WORKSHEET
 LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT        1800 1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
  TH-RT     1800 1 0.900 0.990 1.000 0.798 1.000 0.900 0.965 1.000 1112
  LT-TH     1800 3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.692 3106
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SB  TH-RT     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 0.969 1.000 4354

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB 113  54  3 1083 1083   63 0.06  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu     Fs     Pl     Gq     Pt     Gf        El     Fm   Flt
NB 5400 0.259 32.820 0.001 1.000 20.772 0.000  0.000 1800.000 0.075 0.692

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT         204 1371 0.15 0.45  624 0.33
WB  TH-RT      413 1112 0.37 0.45  506 0.82      *
NB  LT-TH     1192 3106 0.38 0.47 1473 0.81
SB  TH-RT     1688 4354 0.39 0.47 2065 0.82      *

CYCLE=113.0  LOST= 8.0  SUM V/S CRIT= 0.76 TOTAL V/C= 0.82

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1    c     d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.33 0.45 113.0  14.99  624   0.12 1.00   15.11  C    3.5
WB  TH-RT     0.82 0.45 113.0  20.31  506   7.02 0.85   23.23  C    7.1
NB  LT-TH     0.81 0.47 113.0  19.25 1473   2.46 0.71   15.51  C   17.9
SB  TH-RT     0.82 0.47 113.0  19.38 2065   1.92 0.72   15.28  C   25.3

DIR Delay LOS
WB  20.54  C
NB  15.51  C
SB  15.28  C
INTERSECTION DELAY = 16.29 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  113  TO  113 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 113.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  39.9 SECONDS
THE EXISTING TIMING IS OPTIMAL
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NCH PROGRAM VERSION DATE 4-29-1988
85 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
SS AVE @ NEWBURY ST
 BD ALT #2 NL W/BTD PROPOSED IMPS & SIG MOD
te:11-29-1990             time:16:13:31
ST DATA SET NAMES LOADED OR SAVED
LUME=I3AMB2NL   GEOMETRICS=INT3BTD    SIGNAL=I3AMBD
CATED IN CBD:Y
LUME & GEOMETRICS
      VOLUMES      # OF LANES     LANE WIDTH     CROSS
R  LT   TH   RT    LT TH RT       LT   TH   RT     WALK
    0    0    0     0  0  0     0.0  0.0  0.0     0
  118   244  56     1  1  0     9.0  9.0  0.0     0
   69   988    0     0  3  0     0.0 10.0  0.0     0
    0 1486  284     0  3  0     0.0 10.0  0.0     0

AFFIC & ROADWAY CONDITIONS
               ADJ PARK             PEDESTRIANS        ARR
R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
  0.0%  0.0%         0     0  .000    0         7.0    0
  0.0%  2.0%   Y    20     0  .900    0   N     7.0    3
  0.0%  2.0%         0     0  .900    0   N     7.0    4
  0.0%  2.0%         0     0  .900    0   N     7.0    4

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                          *  *           *  *     64.2   4    A
              *  *  *                             38.8   4    A

LE= 111.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
   LTV  THV  RTV   PHF  LTFR THFR RTFR
     0    0    0  .000     0    0    0
   118  244   56  .900   131  271   62
    69  988    0  .900    77 1098    0
     0 1486  284  .900     0 1651  316

RT 2 (LANE GROUP ADJUSTMENTS)
  LN GROUP  FLOW N   LU    v  Plt  Prt
  LT         131 1 1.00  131 1.00 0.00
  TH-RT      333 1 1.00  333 0.00 0.19
  LT-TH     1174 3 1.10 1292 0.07 0.00
  TH-RT     1967 3 1.10 2163 0.00 0.16

 T 3 (OPPOSING VOLUME ADJUSTMENTS)
 T TURN                 OPPOSING APPROACH
 NG OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
               LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
 TBOUND         0    0    0         0    0    0        0   0   0       0
 THBOUND        0 1651  316       100  100  100        0   3   0    1399

 URATION FLOW ADJUSTMENT WORKSHEET
  LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea    Frt   Flt    s
  LT        1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
  TH-RT     1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.972 1.000 1120
  LT-TH     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.688 3088
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SB  TH-RT     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 0.976 1.000 4383

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB 111  64  3 1174 1174   77 0.07  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu     Fs     Pl      Gq     Pt     Gf        El     Fm   Flt
NB 5400 0.259 47.902 0.001 1.000 16.347 0.000  0.000 1800.000 0.063 0.688

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP     v     s  v/s  g/C     c  v/c  CRITICAL
WB  LT         131 1371 0.10 0.35  479 0.27
WB  TH-RT      333 1120 0.30 0.35  391 0.85      *
NB  LT-TH     1292 3088 0.42 0.58 1787 0.72
SB  TH-RT     2163 4383 0.49 0.58 2537 0.85      *

CYCLE=111.0  LOST= 8.0  SUM V/S CRIT= 0.79 TOTAL V/C= 0.85

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C      d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.27 0.35 111.0  19.76  479    0.08 1.00   19.84  C    2.6
WB  TH-RT     0.85 0.35 111.0  25.44  391   11.40 0.85   31.32  D    6.7
NB  LT-TH     0.72 0.58 111.0  12.86 1787    1.03 0.68    9.43  B   15.3
SB  TH-RT     0.85 0.58 111.0  14.78 2537    2.17 0.73   12.38  B   25.5

DIR Delay LOS
WB  28.08  D
NB   9.43  B
SB  12.38  B
INTERSECTION DELAY = 13.27 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  111  TO  111 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 111.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  47.9 SECONDS
THE EXISTING TIMING IS OPTIMAL
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ NEWBURY ST
M BUILD ALT #2 W/BTD PROPOSED IMPS. & SIGNAL OPT
ate:12-03-1990             time:11:06:28
AST DATA SET NAMES LOADED OR SAVED
OLUME=I3PBD2NL   GEOMETRICS=INT3BTD    SIGNAL=I3PMBTD
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
3    0    0    0     0  0  0     0.0  0.0  0.0     0
3  220  370  103     1  1  0     9.0  9.0  0.0     0
3   68 1094    0     0  3  0     0.0 10.0  0.0     0
3    0 1334  344     0  3  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
3  0.0%  0.0%         0    0  .000    0          7.0    0
3  0.0%  2.0%   Y    20    0  .900    0   N      7.0    3
3  0.0%  2.0%         0    0  .900    0   N      7.0    4
3  0.0%  2.0%         0    0  .900    0   N      7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *     52.0    4    A
               *  *  *                             52.0    4    A

CLE= 112.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R  LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0 .000     0    0    0
    220  370  103 .900   244  411  114
     68 1094    0 .900    76 1216    0
      0 1334  344 .900     0 1482  382

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N   LU     v  Plt  Prt
  LT          244 1 1.00  244 1.00 0.00
  TH-RT       526 1 1.00  526 0.00 0.22
  LT-TH      1291 3 1.10 1420 0.06 0.00
  TH-RT      1864 3 1.10 2051 0.00 0.21

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                OPPOSING APPROACH
ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
STBOUND          0    0    0         0    0    0         0   0   0       0
RTHBOUND         0 1482  382       100  100  100         0   3   0    1399

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt     s
  LT          1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
  TH-RT       1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.967 1.000 1114
  LT-TH       1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.692 3110
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SB  TH-RT     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 0.969 1.000 4353

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB 112  52  3 1291 1291   76 0.06  3 1399 0.00
CALCULATIONS
DIR Sop     Yo     Gu     Fs     Pl      Gq     Pt     Gf        El     Fm    Flt
NB 5400 0.259 30.984 0.001 1.000 20.989 0.000  0.000 1800.000 0.077 0.692

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP     v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT         244 1371 0.18 0.46  637 0.38
WB  TH-RT      526 1114 0.47 0.46  518 1.02      *
NB  LT-TH     1420 3110 0.46 0.46 1443 0.98
SB  TH-RT     2051 4353 0.47 0.46 2020 1.02      *

CYCLE=112.0  LOST= 8.0  SUM V/S CRIT= 0.94 TOTAL V/C= 1.02

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.38 0.46 112.0  14.85  637    0.20 1.00   15.05  C   4.1
WB  TH-RT     1.02 0.46 112.0  23.10  518   34.44 0.85   48.90  E  11.5
NB  LT-TH     0.98 0.46 112.0  22.50 1443   15.05 0.77   29.09  D  21.5
SB  TH-RT     1.02 0.46 112.0  23.12 2020   18.95 0.78   32.98  D  32.6

DIR Delay LOS
WB  38.16  D
NB  29.09  D
SB  32.98  D
INTERSECTION DELAY = 32.62 INTERSECTION LOS=D

THE CYCLE LENGTH WITHIN THE BOUNDS OF  112  TO  112 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 112.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE %1052.1 SECONDS
THE EXISTING TIMING IS OPTIMAL
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ NEWBURY ST
AT BD ALT #2 W/BTD IMPS & SIG. OPT
ate:12-03-1990             time:11:07:34
AST DATA SET NAMES LOADED OR SAVED
 LUME=I3SBD2NL   GEOMETRICS=INT3BTD    SIGNAL=I3PMBTD
 CATED IN CBD:Y
 LUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
 R LT    TH   RT    LT TH RT      LT   TH   RT    WALK
     0    0    0     0  0  0     0.0  0.0  0.0     0
   184  294   87     1  1  0     9.0  9.0  0.0     0
    57  918    0     0  3  0     0.0 10.0  0.0     0
     0 1107  273     0  3  0     0.0 10.0  0.0     0

 AFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
 R GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
   0.0%  0.0%         0    0  .000    0         7.0    0
   0.0%  2.0%   Y    20    0  .900    0   N     7.0    3
   0.0%  2.0%         0    0  .900    0   N     7.0    4
   0.0%  2.0%         0    0  .900    0   N     7.0    4

 ASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *     52.0   4    A
               *  *  *                             52.0   4    A

 CLE= 112.0

 LUME ADJUSTMENT WORKSHEET
 RT 1 (MOVEMENT ADJUSTMENTS)
 R  LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0  .000     0    0    0
    184  294   87  .900   204  327   97
     57  918    0  .900    63 1020    0
      0 1107  273  .900     0 1230  303

 RT 2 (LANE GROUP ADJUSTMENTS)
   LN GROUP   FLOW N   LU     v  Plt  Prt
   LT          204 1 1.00  204 1.00 0.00
   TH-RT       423 1 1.00  423 0.00 0.23
   LT-TH      1083 3 1.10 1192 0.06 0.00
   TH-RT      1533 3 1.10 1687 0.00 0.20

  T 3 (OPPOSING VOLUME ADJUSTMENTS)
  T TURN                OPPOSING APPROACH
  NG OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
   TBOUND       0    0    0         0    0    0        0   0   0       0
  THBOUND       0 1230  303       100  100  100        0   3   0    1399

  URATION FLOW ADJUSTMENT WORKSHEET
   LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
    LT       1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
   TH-RT     1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.966 1.000 1113
   LT-TH     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.692 3110
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SB  TH-RT     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 0.970 1.000 4358

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB 112  52  3 1083 1083   63 0.06  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.259 30.984 0.001 1.000 20.989 0.000  0.000 1800.000 0.077 0.692

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT        204 1371 0.15 0.46  637 0.32
WB  TH-RT     423 1113 0.38 0.46  517 0.82     *
NB  LT-TH    1192 3110 0.38 0.46 1443 0.83
SB  TH-RT    1687 4358 0.39 0.46 2022 0.83     *

CYCLE=112.0  LOST= 8.0  SUM V/S CRIT= 0.77 TOTAL V/C= 0.83

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1     c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.32 0.46 112.0  14.34  637    0.11 1.00   14.45  B   3.4
WB  TH-RT    0.82 0.46 112.0  19.70  517    6.98 0.85   22.68  C   7.1
NB  LT-TH    0.83 0.46 112.0  19.82 1443    2.90 0.72   16.37  C  18.1
SB  TH-RT    0.83 0.46 112.0  19.94 2022    2.26 0.72   16.07  C  25.6

DIR Delay LOS
WB  20.00  C
NB  16.37  C
SB  16.07  C
INTERSECTION DELAY = 16.88 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  112  TO  112 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 112.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  41.7 SECONDS
for chosen cycle length 112.0
suggested timing phase 1 is  52.4 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  51.6 secs green,   4.0 secs yellow + red clear
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ NEWBURY ST
M BUILS ALT. #3 W/ BTD PROP.IMPS & SIG OPT
ate:12-03-1990             time:11:10:39
AST DATA SET NAMES LOADED OR SAVED
OLUME=I3AMB3NL   GEOMETRICS=INT3BTD    SIGNAL=I3AMBDA3
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B     0    0    0     0  0  0     0.0  0.0  0.0     0
B   118  218   56     1  1  0     9.0  9.0  0.0     0
B    69  988    0     0  3  0     0.0 10.0  0.0     0
B     0 1484  263     0  3  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%         0    0   .000    0         7.0    0
B  0.0%  2.0%   Y    20    0   .900    0   N     7.0    3
B  0.0%  2.0%         0    0   .900    0   N     7.0    4
B  0.0%  2.0%         0    0   .900    0   N     7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
1                          *  *           *  *     66.0   4    A
2              *  *  *                             37.0   4    A

YCLE= 111.0

OLUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
B     0    0    0  .000     0    0    0
B   118  218   56  .900   131  242   62
B    69  988    0  .900    77 1098    0
B     0 1484  263  .900     0 1649  292

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP  FLOW N   LU     v  Plt  Prt
   LT         131 1 1.00  131 1.00 0.00
   TH-RT      304 1 1.00  304 0.00 0.20
   LT-TH     1174 3 1.10 1292 0.07 0.00
   TH-RT     1941 3 1.10 2135 0.00 0.15

 RT 3 (OPPOSING VOLUME ADJUSTMENTS)
 FT TURN                OPPOSING APPROACH
 ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
 STBOUND         0    0    0         0    0    0        0   0   0       0
 RTHBOUND        0 1649  292       100  100  100        0   3   0    1399

 TURATION FLOW ADJUSTMENT WORKSHEET
 R LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt  s
   LT        1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
   TH-RT     1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.969 1.000 1117
   LT-TH     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.687 3085
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SB  TH-RT     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 0.977 1.000 4390

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB 111  66  3 1174 1174   77 0.07  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.259 50.271 0.001 1.000 15.733 0.000  0.000 1800.000 0.061 0.687

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT          131 1371 0.10 0.33  457 0.29
WB  TH-RT       304 1117 0.27 0.33  372 0.82     *
NB  LT-TH      1292 3085 0.42 0.59 1835 0.70
SB  TH-RT      2135 4390 0.49 0.59 2610 0.82     *

CYCLE=111.0  LOST= 8.0  SUM V/S CRIT= 0.76 TOTAL V/C= 0.82

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1     c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.29 0.33 111.0  20.73  457    0.10 1.00   20.83  C    2.7
WB  TH-RT    0.82 0.33 111.0  25.78  372    9.18 0.85   29.72  D    6.3
NB  LT-TH    0.70 0.59 111.0  11.92 1835    0.88 0.67    8.58  B   14.7
SB  TH-RT    0.82 0.59 111.0  13.50 2610    1.54 0.72   10.79  B   24.3

DIR Delay LOS
WB  27.04  D
NB   8.58  B
SB  10.79  B
INTERSECTION DELAY = 11.88 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  111  TO  111 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 111.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  39.8 SECONDS
THE EXISTING TIMING IS OPTIMAL
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ NEWBURY ST
M BUILD ALT #3 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT.
ate:12-03-1990               time:11:12:46
AST DATA SET NAMES LOADED OR SAVED
OLUME=I3PMB3NL   GEOMETRICS=INT3BTD    SIGNAL=I3PMA3OP
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES       # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT     WALK
B    0    0    0     0  0  0      0.0  0.0  0.0      0
B  220  374  103     1  1  0      9.0  9.0  0.0      0
B   68 1094    0     0  3  0      0.0 10.0  0.0      0
B    0 1320  349     0  3  0      0.0 10.0  0.0      0

RAFFIC & ROADWAY CONDITIONS
                 ADJ PARK                PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
3  0.0%  0.0%          0     0  .000    0           7.0    0
3  0.0%  2.0%   Y     20     0  .900    0   N       7.0    3
3  0.0%  2.0%          0     0  .900    0   N       7.0    4
3  0.0%  2.0%          0     0  .900    0   N       7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *      51.6   4    A
               *  *  *                              52.4   4    A

CLE= 112.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R   LTV  THV   RTV   PHF  LTFR THFR RTFR
      0    0     0  .000     0    0    0
    220  374   103  .900   244  416  114
     68 1094     0  .900    76 1216    0
      0 1320   349  .900     0 1467  388

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N   LU     v  Plt  Prt
  LT          244 1 1.00   244 1.00 0.00
  TH-RT       530 1 1.00   530 0.00 0.22
  LT-TH      1291 3 1.10  1420 0.06 0.00
  TH-RT      1854 3 1.10  2040 0.00 0.21

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                  OPPOSING APPROACH
ING OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES      OPPOSING
                LT   TH   RT        LT   TH   RT        LT  TH  RT     VOLUME
STBOUND          0    0    0         0    0    0         0   0   0        0
RTHBOUND         0 1467  388       100  100  100         0   3   0      1399

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP  IDEAL N   Fwid   Fhv   Fgr  Fpark  Fbus  Farea   Frt   Flt    s
  LT         1800 1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
  TH-RT      1800 1 0.900 0.990 1.000 0.798 1.000 0.900 0.968 1.000 1115
  LT-TH      1800 3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.693 3111
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SB  TH-RT     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 0.969 1.000 4350

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB 112  52  3 1291 1291   76 0.06  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu     Fs     Pl      Gq     Pt     Gf        El     Fm   Flt
NB 5400 0.259 30.532 0.001 1.000 21.106 0.000  0.000 1800.000 0.078 0.693

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT         244 1371 0.18 0.47  641 0.38
WB  TH-RT      530 1115 0.48 0.47  521 1.02      *
NB  LT-TH     1420 3111 0.46 0.46 1434 0.99
SB  TH-RT     2040 4350 0.47 0.46 2006 1.02      *

CYCLE=112.0  LOST= 8.0  SUM V/S CRIT= 0.94 TOTAL V/C= 1.02

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c     d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.38 0.47 112.0  14.69  641    0.19 1.00   14.88  B   4.0
WB  TH-RT     1.02 0.47 112.0  23.01  521   34.82 0.85   49.15  E  11.6
NB  LT-TH     0.99 0.46 112.0  22.75 1434   16.26 0.78   30.29  D  21.7
SB  TH-RT     1.02 0.46 112.0  23.28 2006   19.46 0.78   33.52  D  32.8

DIR Delay LOS
WB  38.33  D
NB  30.29  D
SB  33.52  D
INTERSECTION DELAY = 33.32 INTERSECTION LOS=D

THE CYCLE LENGTH WITHIN THE BOUNDS OF  112  TO  112 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 112.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE %1357.3 SECONDS
THE EXISTING TIMING IS OPTIMAL
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ NEWBURY ST
AT BUILD ALT #3 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-03-1990             time:11:14:59
AST DATA SET NAMES LOADED OR SAVED
OLUME=I3SAB3NL   GEOMETRICS=INT3BTD    SIGNAL=I3SABDA3
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B    0    0    0     0  0  0     0.0  0.0  0.0     0
B  184  311   87     1  1  0     9.0  9.0  0.0     0
B   57  918    0     0  3  0     0.0 10.0  0.0     0
B    0 1113  308     0  3  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK                 PEDESTRIANS         ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%          0   0   .000    0         7.0    0
B  0.0%  2.0%   Y     20   0   .900    0   N     7.0    3
B  0.0%  2.0%          0   0   .900    0   N     7.0    4
B  0.0%  2.0%          0   0   .900    0   N     7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
1                          *  *           *  *     53.2   4    A
2              *  *  *                             52.8   4    A

YCLE= 114.0

OLUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
B      0    0    0  .000     0    0    0
B    184  311   87  .900   204  346   97
B     57  918    0  .900    63 1020    0
B      0 1113  308  .900     0 1237  342

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP   FLOW N   LU     v  Plt  Prt
B  LT         204 1 1.00  204 1.00 0.00
B  TH-RT      442 1 1.00  442 0.00 0.22
B  LT-TH     1083 3 1.10 1192 0.06 0.00
B  TH-RT     1579 3 1.10 1737 0.00 0.22

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                OPPOSING APPROACH
EING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT         LT   TH   RT       LT  TH  RT     VOLUME
ESTBOUND         0    0    0          0    0    0        0   0   0       0
ORTHBOUND        0 1237  342       100  100  100        0   3   0    1399

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP   IDEAL N  Fwid   Fhv    Fgr Fpark   Fbus Farea   Frt   Flt     s
B  LT         1800  1 0.900 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1371
B  TH-RT      1800  1 0.900 0.990 1.000 0.798 1.000 0.900 0.967 1.000 1114
B  LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.692 3107
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SB  TH-RT     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 0.967 1.000 4345

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB 114  53  3 1083 1083   63 0.06  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.259 31.923 0.001 1.000 21.264 0.000  0.000 1800.000 0.076 0.692

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT         204 1371 0.15 0.46  635 0.32
WB  TH-RT      442 1114 0.40 0.46  516 0.86     *
NB  LT-TH     1192 3107 0.38 0.47 1450 0.82
SB  TH-RT     1737 4345 0.40 0.47 2027 0.86     *

CYCLE=114.0  LOST= 8.0  SUM V/S CRIT= 0.80 TOTAL V/C= 0.86

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.32 0.46 114.0  14.67  635    0.11 1.00   14.77  B   3.5
WB  TH-RT    0.86 0.46 114.0  20.69  516    9.36 0.85   25.54  D   7.5
NB  LT-TH    0.82 0.47 114.0  20.00 1450    2.79 0.72   16.39  C  18.3
SB  TH-RT    0.86 0.47 114.0  20.54 2027    2.78 0.73   17.07  C  26.7

DIR Delay LOS
WB  22.14  C
NB  16.39  C
SB  17.07  C
INTERSECTION DELAY = 17.76 INTERSECTION LOS=C

THE CYCLE LENGTH WITHIN THE BOUNDS OF  114  TO  114 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS 114.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  49.5 SECONDS
THE EXISTING TIMING IS OPTIMAL
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
MASS AVE @ COMM AVE EB
AM EX
date:07-03-1990             time:08:17:35
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I4AMEX     GEOMETRICS=INT4       SIGNAL=I4AMEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES      # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
EB  135   30  380     0  2  0     0.0 10.0  0.0     0
WB    0    0    0     0  0  0     0.0  0.0  0.0     0
NB    0  935   74     0  2  0     0.0 10.0  0.0     0
SB  101 1154    0     0  2  0     0.0 10.0  0.0     0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK             PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  2.0%   Y    10    0   .900    0   N     7.0    3
WB  0.0%  0.0%         0    0   .000    0         7.0    0
NB  0.0%  2.0%   Y    10    0   .900    0   N     7.0    4
SB  0.0%  2.0%   N     0    0   .900    0   N     7.0    5

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                             *  *     *  *         62.0   4    A
 2  *  *  *                                          21.0   4    A

CYCLE=  91.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
 IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
 B   135   30  380  .900   150   33  422
 B     0    0    0  .000     0    0    0
 B     0  935   74  .900     0 1039   82
 B   101 1154    0  .900   112 1282    0

 ART 2 (LANE GROUP ADJUSTMENTS)
 IR LN GROUP  FLOW N   LU    v  Plt  Prt
 B  LT-TH-RT   606 2 1.05  636 0.25 0.70
 B  TH-RT     1121 2 1.05 1177 0.00 0.07
 B  LT-TH     1394 2 1.05 1464 0.08 0.00

 ART 3 (OPPOSING VOLUME ADJUSTMENTS)
 EFT TURN                OPPOSING APPROACH
 EING OPPOSED       VOLUMES       % OPPOSING LEFT TURN    # LANES     OPPOSING
                  LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
 ASTBOUND          0    0    0         0    0    0        0   0   0       0
 UTHBOUND          0 1039   82       100  100  100        0   2   0    1121

 ATURATION FLOW ADJUSTMENT WORKSHEET
 IR LN GROUP  IDEAL N   Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
 B  LT-TH-RT  1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.895 1.000 2479
 B  TH-RT     1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.989 1.000 2738
 B  LT-TH     1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.654 1957

 UPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
 NPUT VARIABLES
 IR  C    G  N   Va   Vm  Vlt  Plt No   Vo Plto
     91   62  2 1394 1394  112 0.08  2 1121 0.00
 LCULATIONS
 IR Sop    Yo      Gu    Fs     Pl     Gq     Pt     Gf        El    Fm   Flt
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SB 3600 0.311 48.884 0.174 0.464 13.116 0.536  2.274    6.454 0.307 0.654

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT-TH-RT  636 2479 0.26 0.23  572 1.11     *
NB  TH-RT    1177 2738 0.43 0.68 1865 0.63
SB  LT-TH    1464 1957 0.75 0.68 1333 1.10     *

CYCLE= 91.0  LOST= 8.0  SUM V/S CRIT= 1.00 TOTAL V/C= 1.10

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C      d1     c      d2    PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 1.11 0.23   91.0  27.52  572   68.50 0.85   81.62  F  19.6
NB  TH-RT    0.63 0.68   91.0   6.16 1865    0.50 0.64    4.24  A   9.0
SB  LT-TH    1.10 0.68   91.0  13.94 1333   51.95 0.65   42.78  E  22.2

DIR Delay LOS
EB  81.62  F
NB   4.24  A
SB  42.78  E
INTERSECTION DELAY = 36.47 INTERSECTION LOS=D

THE CYCLE LENGTH WITHIN THE BOUNDS OF  91  TO  91 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  91.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length  91.0
suggested timing phase 1 is  61.8 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  21.2 secs green,   4.0 secs yellow + red clear
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
MASS AVE @ COMM AVE EB
PM EX
date:07-03-1990             time:08:18:48
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I4PMEX     GEOMETRICS=INT4        SIGNAL=I4PMEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
       VOLUMES         # OF LANES      LANE WIDTH      CROSS
DIR  LT    TH    RT     LT TH RT      LT    TH    RT     WALK
EB  104    59   316      0  2  0      0.0 10.0   0.0      0
WB    0     0     0      0  0  0      0.0  0.0   0.0      0
NB    0   947   175      0  2  0      0.0 10.0   0.0      0
SB  128  1233     0      0  2  0      0.0 10.0   0.0      0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK                PEDESTRIANS         ARR
DIR GRADE %HV    Y/N MOVES BUSES   PHF CROSS BUT MIN TIME TYPE
EB  0.0%  2.0%    Y    10     0   .900    0   N      7.0    3
WB  0.0%  0.0%          0     0   .000    0          7.0    0
NB  0.0%  2.0%    Y    10     0   .900    0   N      7.0    4
SB  0.0%  2.0%    N     0     0   .900    0   N      7.0    5

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                             *  *        *  *        65.0   4    A
 2  *  *  *                                            19.0   4    A

CYCLE=  92.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR  LTV  THV  RTV   PHF  LTFR THFR RTFR
EB   104   59  316  .900   116   66  351
WB     0    0    0  .000     0    0    0
NB     0  947  175  .900     0 1052  194
SB   128 1233    0  .900   142 1370    0

PART 2 (LANE GROUP ADJUSTMENTS)
DIR LN GROUP  FLOW N   LU     v  Plt  Prt
EB  LT-TH-RT   532 2 1.05   559 0.22 0.66
NB  TH-RT     1247 2 1.05  1309 0.00 0.16
SB  LT-TH     1512 2 1.05  1588 0.09 0.00

PART 3 (OPPOSING VOLUME ADJUSTMENTS)
LEFT TURN                 OPPOSING APPROACH
BEING OPPOSED       VOLUMES       % OPPOSING LEFT TURN     # LANES     OPPOSING
                  LT   TH   RT        LT   TH   RT        LT  TH  RT    VOLUME
EASTBOUND          0    0    0         0    0    0         0   0   0        0
SOUTHBOUND         0 1052  194       100  100  100         0   2   0     1247

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP  IDEAL N  Fwid    Fhv    Fgr  Fpark  Fbus  Farea   Frt    Flt    s
B  LT-TH-RT  1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.901 1.000 2494
B  TH-RT     1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.977 1.000 2703
B  LT-TH     1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.575 1722

UPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
NPUT VARIABLES
IR  C   G  N    Va   Vm  Vlt  Plt No   Vo Plto
B  92  65  2 1512 1399  142 0.09  2 1247 0.00
ALCULATIONS
IR Sop     Yo      Gu     Fs     Pl     Gq     Pt     Gf       El     Fm    Flt
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SB 3600 0.346 50.697 0.096 0.747 14.303 0.253  0.676   11.739 0.151 0.575

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT-TH-RT  559 2494 0.22 0.21  515 1.08     *
NB  TH-RT    1309 2703 0.48 0.71 1910 0.69
SB  LT-TH    1588 1722 0.92 0.71 1217 1.30     *

CYCLE= 92.0  LOST= 8.0  SUM V/S CRIT= 1.15 TOTAL V/C= 1.26

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 1.08 0.21  92.0  28.37  515   58.49 0.85   73.82  F  16.3
NB  TH-RT    0.69 0.71  92.0   5.84 1910    0.73 0.66    4.35  A   9.4
SB  LT-TH    1.30 0.71  92.0  38.52 1217  187.45 0.74  166.71  F  75.7

DIR Delay LOS
EB   73.82  F
NB    4.35  A
SB 166.71   F
INTERSECTION DELAY = 90.19 INTERSECTION LOS=F

THE CYCLE LENGTH WITHIN THE BOUNDS OF  92  TO  92 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  92.0 SECONDS

THE V/C RATIO CAN’T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length  92.0
suggested timing phase 1 is  67.6 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  16.4 secs green,   4.0 secs yellow + red clear
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CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
MASS AVE @ COMM AVE EB
SAT EX
date:07-03-1990             time:08:20:45
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I4SATEX    GEOMETRICS=INT4      SIGNAL=I4SATEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES       # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT    LT TH RT      LT   TH    RT    WALK
EB   87   50  265     0  2  0     0.0 10.0  0.0      0
WB    0    0    0     0  0  0     0.0  0.0  0.0      0
NB    0  795  147     0  2  0     0.0 10.0  0.0      0
SB  108 1036    0     0  2  0     0.0 10.0  0.0      0

TRAFFIC & ROADWAY CONDITIONS
                  ADJ PARK               PEDESTRIANS         ARR
DIR GRADE %HV    Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB   0.0%  2.0%   Y     10    0   .900    0   N      7.0    3
WB   0.0%  0.0%          0    0   .000    0          7.0    0
NB   0.0%  2.0%   Y     10    0   .900    0   N      7.0    4
SB   0.0%  2.0%   N      0    0   .900    0   N      7.0    5

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                                 *  *     *  *       55.0   4    A
 2  *  *  *                                            19.0   4    A

:YCLE=  82.0

/OLUME ADJUSTMENT WORKSHEET
?ART 1 (MOVEMENT ADJUSTMENTS)
)IR   LTV  THV  RTV   PHF  LTFR THFR RTFR
:B     87   50  265  .900    97   56  294
/B      0    0    0  .000     0    0    0
IB      0  795  147  .900     0  883  163
;B    108 1036    0  .900   120 1151    0

'ART 2 (LANE GROUP ADJUSTMENTS)
'IR LN GROUP   FLOW N   LU    v  Plt  Prt
:B  LT-TH-RT    447 2 1.05  469 0.22 0.66
B   TH-RT      1047 2 1.05 1099 0.00 0.16
B   LT-TH      1271 2 1.05 1335 0.09 0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                 OPPOSING APPROACH
EING OPPOSED         VOLUMES       % OPPOSING LEFT TURN     # LANES     OPPOSING
                  LT   TH   RT         LT   TH   RT       LT  TH  RT     VOLUME
ASTBOUND           0    0    0          0    0    0        0   0   0        0
OUTHBOUND          0  883  163        100  100  100        0   2   0     1047

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
B  LT-TH-RT   1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.901 1.000 2494
3  TH-RT      1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.977 1.000 2703
3  LT-TH      1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.686 2053

JPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
NPUT VARIABLES
IR   C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
3  82  55  2 1271 1271  120 0.09  2 1047 0.00
LCULATIONS
IR Sop     Yo     Gu     Fs     Pl     Gq     Pt     Gf        El     Fm    Flt
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SB 3600 0.291 43.932 0.221 0.460 11.068 0.540  2.270    5.094 0.371 0.686

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT-TH-RT  469 2494 0.19 0.23  578 0.81     *
NB  TH-RT    1099 2703 0.41 0.67 1813 0.61
SB  LT-TH    1335 2053 0.65 0.67 1377 0.97     *

CYCLE= 82.0  LOST= 8.0  SUM V/S CRIT= 0.84 TOTAL V/C= 0.93

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 0.81 0.23  82.0  22.65  578    5.96 0.85   24.32  C    7.8
NB  TH-RT    0.61 0.67  82.0   5.69 1813    0.43 0.62    3.81  A    7.9
SB  LT-TH    0.97 0.67  82.0   9.66 1377   12.96 0.59   13.34  B    9.5

DIR Delay LOS
EB  24.32  C
NB   3.81  A
SB  13.34  B
INTERSECTION DELAY = 11.51 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  82  TO  82 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  82.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  67.9 SECONDS
for chosen cycle length  82.0
suggested timing phase 1 is  57.4 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  16.6 secs green,   4.0 secs yellow + red clear
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 INCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
 ASS AVE @ COMM AVE WB
 M NO BUILD W/BTD PROPOSED IMPS. & SIG OPT
 ate:12-03-1990             time:11:31:19
 AST DATA SET NAMES LOADED OR SAVED
 OLUME=I4AMNB     GEOMETRICS=INT4BTD    SIGNAL=I4AMBTD
 OCATED IN CBD:Y
 OLUME & GEOMETRICS
        VOLUMES      # OF LANES     LANE WIDTH     CROSS
 IR   LT    TH   RT    LT TH RT       LT   TH    RT    WALK
 B  138   31  430     0  2  0     0.0 10.0  0.0     0
 B    0    0    0     0  0  0     0.0  0.0  0.0     0
 B    0  954   75     0  3  0     0.0 10.0  0.0     0
 B  103 1306    0     0  3  0     0.0 10.0  0.0     0

 RAFFIC & ROADWAY CONDITIONS
                ADJ PARK                PEDESTRIANS         ARR
 IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
 B  0.0%  2.0%   Y    10     0   .900    0   N     7.0    3
 B  0.0%  0.0%         0     0   .000    0         7.0    0
 B  0.0%  2.0%   Y    10     0   .900    0   N     7.0    4
 B  0.0%  2.0%   N     0     0   .900    0   N     7.0    5

 HASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                             *  *     *  *        57.6   4    A
 2  *  *  *                                         31.4   4    A

 YCLE=  97.0

 OLUME ADJUSTMENT WORKSHEET
 ART 1 (MOVEMENT ADJUSTMENTS)
 IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
 B   138   31  430  .900   153   34  478
 B     0    0    0  .000     0    0    0
 B     0  954   75  .900     0 1060   83
 B   103 1306    0  .900   114 1451    0

 RT 2 (LANE GROUP ADJUSTMENTS)
 IR LN GROUP   FLOW N   LU     v  Plt  Prt
 B  LT-TH-RT   666 2 1.05  699 0.23 0.72
 B  TH-RT     1143 3 1.10 1258 0.00 0.07
 B  LT-TH     1566 3 1.10 1722 0.07 0.00

 RT 3 (OPPOSING VOLUME ADJUSTMENTS)
 FT TURN                 OPPOSING APPROACH
 EING OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES      OPPOSING
                 LT    TH   RT       LT    TH   RT         LT  TH  RT     VOLUME
 ASTBOUND         0     0    0        0     0    0          0   0   0         0
 OUTHBOUND        0  1060   83      100   100  100          0   3   0      1143

 TURATION FLOW ADJUSTMENT WORKSHEET
  R LN GROUP   IDEAL N   Fwid    Fhv    Fgr Fpark  Fbus Farea   Frt   Flt     s
    LT-TH-RT  1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.892 1.000 2470
    TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.989 1.000 4218
    LT-TH     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.739 3318
```

```
SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
SB  97  58  3 1566 1399  114 0.07  3 1143 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
SB 5400 0.212 47.011 0.160 0.772 10.584 0.228  0.589    7.013 0.216 0.739

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s g/C     c  v/c  CRITICAL
EB  LT-TH-RT  699 2470 0.28 0.32  800 0.87     *
NB  TH-RT    1258 4218 0.30 0.59 2505 0.50
SB  LT-TH    1722 3318 0.52 0.59 1970 0.87     *

CYCLE= 97.0  LOST= 8.0  SUM V/S CRIT= 0.80 TOTAL V/C= 0.87

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 0.87 0.32  97.0  23.51  800    7.48 0.85   26.34  D   12.1
NB  TH-RT    0.50 0.59  97.0   8.67 2505    0.14 0.62    5.46  B   12.5
SB  LT-TH    0.87 0.59  97.0  12.65 1970    3.38 0.54    8.72  B   17.1

DIR Delay  LOS
EB  26.34  D
NB   5.46  B
SB   8.72  B
INTERSECTION DELAY = 10.95 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  97  TO  97 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  97.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  51.3 SECONDS
THE EXISTING TIMING IS OPTIMAL
```

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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE WB
M NO BUILD W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-03-1990             time:11:33:43
AST DATA SET NAMES LOADED OR SAVED
OLUME=I4PMNB     GEOMETRICS=INT4BTD    SIGNAL=I4PMBTD
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR LT    TH   RT    LT TH RT      LT   TH   RT    WALK
B  106   60  334      0  2  0    0.0 10.0  0.0      0
B    0    0    0      0  0  0    0.0  0.0  0.0      0
B    0  972  180      0  3  0    0.0 10.0  0.0      0
B  131 1306    0      0  3  0    0.0 10.0  0.0      0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS      ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  2.0%   Y    10    0  .900     0   N    7.0     3
B  0.0%  0.0%          0    0  .000     0          7.0     0
B  0.0%  2.0%   Y    10    0  .900     0   N    7.0     4
B  0.0%  2.0%   N     0    0  .900     0   N    7.0     5

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
1                             *  *     *  *        59.7   4    A
2  *  *  *                                         25.3   4    A

YCLE=  93.0

OLUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
B   106   60  334  .900   118   67  371
B     0    0    0  .000     0    0    0
B     0  972  180  .900     0 1080  200
B   131 1306    0  .900   146 1451    0

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP  FLOW N   LU    v  Plt  Prt
B  LT-TH-RT   556 2 1.05  583 0.21 0.67
B  TH-RT     1280 3 1.10 1408 0.00 0.16
B  LT-TH     1597 3 1.10 1756 0.09 0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                OPPOSING APPROACH
EING OPPOSED       VOLUMES      % OPPOSING LEFT TURN     # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT     VOLUME
ASTBOUND         0    0    0         0    0    0        0   0   0        0
OUTHBOUND        0 1080  200       100  100  100        0   3   0     1280

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt     s
B  LT-TH-RT  1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.900 1.000  2491
B  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.977 1.000  4165
B  LT-TH     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.707  3177
```

```
SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
SB  93  60  3 1597 1399  146 0.09  3 1280 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
SB 5400 0.237 49.394 0.075 1.000 10.336 0.000  0.000   15.000 0.122 0.707

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT-TH-RT  583 2491 0.23 0.27  677 0.86     *
NB  TH-RT    1408 4165 0.34 0.64 2675 0.53
SB  LT-TH    1756 3177 0.55 0.64 2040 0.86     *

CYCLE= 93.0  LOST= 8.0  SUM V/S CRIT= 0.79 TOTAL V/C= 0.86

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1    c      d2    PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 0.86 0.27  93.0  24.48  677     7.78 0.85   27.42  D  10.5
NB  TH-RT    0.53 0.64  93.0   6.83 2675     0.16 0.62    4.33  A  11.8
SB  LT-TH    0.86 0.64  93.0  10.11 2040     2.88 0.54    6.98  B  14.8

DIR Delay LOS
EB  27.42  D
NB   4.33  A
SB   6.98  B
INTERSECTION DELAY =  9.17 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  93  TO  93 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  93.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  46.6 SECONDS
for chosen cycle length  93.0
suggested timing phase 1 is  59.7 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  25.3 secs green,   4.0 secs yellow + red clear
```

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:INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE.
AT NO BUILD W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990              time:08:46:27
AST DATA SET NAMES LOADED OR SAVED
OLUME=I4SATNB    GEOMETRICS=INT4BTD    SIGNAL=I4SATNB
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES        # OF LANES      LANE WIDTH      CROSS
IR   LT    TH    RT     LT  TH  RT      LT    TH    RT      WALK
B    89    51   281      0   2   0     0.0  10.0   0.0       0
B     0     0     0      0   0   0     0.0   0.0   0.0       0
B     0   817   151      0   3   0     0.0  10.0   0.0       0
B   110  1097     0      0   3   0     0.0  10.0   0.0       0

RAFFIC & ROADWAY CONDITIONS
                  ADJ PARK                PEDESTRIANS       ARR
IR GRADE  %HV    Y/N MOVES  BUSES  PHF  CROSS  BUT MIN TIME TYPE
B  0.0%   2.0%    Y    10      0   .900    0    N      7.0    3
B  0.0%   0.0%          0      0   .000    0           7.0    0
B  0.0%   2.0%    Y    10      0   .900    0    N      7.0    4
B  0.0%   2.0%    N     0      0   .900    0    N      7.0    5

HASINGS
   EASTBOUND    WESTBOUND    NORTHBOUND   SOUTHBOUND GREEN   Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
l                              *  *     *  *        58.6    4     A
2  *  *  *                                          26.4    4     A

YCLE=  93.0

)LUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR   LTV   THV   RTV    PHF   LTFR THFR RTFR
      89    51   281   .900     99   57  312
       0     0     0   .000      0    0    0
       0   817   151   .900      0  908  168
     110  1097     0   .900    122 1219    0

ART 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N    LU     v   Plt   Prt
  LT-TH-RT    468 2  1.05   491 0.21 0.67
  TH-RT      1076 3  1.10  1183 0.00 0.16
  LT-TH      1341 3  1.10  1475 0.09 0.00

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                    OPPOSING APPROACH
ING OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES      OPPOSING
               LT    TH    RT        LT    TH    RT       LT  TH  RT    VOLUME
STBOUND         0     0     0         0     0     0        0   0   0        0
UTHBOUND        0   908   168       100   100   100        0   3   0     1076

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP   IDEAL N  Fwid   Fhv    Fgr  Fpark  Fbus  Farea   Frt   Flt     s
  LT-TH-RT   1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.900 1.000 2491
  TH-RT      1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.977 1.000 4165
  LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.750 3368
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SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va    Vm   Vlt  Plt No   Vo Plto
SB  93  59  3 1341 1341  122 0.09  3 1076 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
SB 5400 0.199 50.042 0.203 0.820  8.556 0.180  0.438    5.548 0.250 0.750

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s   g/C    c  v/c  CRITICAL
EB  LT-TH-RT  491 2491 0.20 0.28  707 0.69     *
NB  TH-RT    1183 4165 0.28 0.63 2624 0.45
SB  LT-TH    1475 3368 0.44 0.63 2122 0.70     *

CYCLE= 93.0  LOST= 8.0  SUM V/S CRIT= 0.64 TOTAL V/C= 0.69

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 0.69 0.28  93.0  22.57  707    2.06 0.85   20.94  C   8.7
NB  TH-RT    0.45 0.63  93.0   6.75 2624    0.09 0.62    4.24  A  10.3
SB  LT-TH    0.70 0.63  93.0   8.60 2122    0.71 0.45    4.20  A  12.8

DIR Delay LOS
EB  20.94  C
NB   4.24  A
SB   4.20  A
INTERSECTION DELAY =  6.83 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  93  TO  93 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  93.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  24.1 SECONDS
for chosen cycle length  93.0
suggested timing phase 1 is  58.6 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  26.4 secs green,   4.0 secs yellow + red clear
```

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:INCH PROGRAM VERSION DATE 4-29-1988
.985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
IASS AVE @ COMM AVE WB
\M BUILD ALT #2 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
late:12-05-1990             time:08:48:56
.AST DATA SET NAMES LOADED OR SAVED
'OLUME=I4AMBDA2   GEOMETRICS=INT4BTD    SIGNAL=I4AMB2OP
.OCATED IN CBD:Y
'OLUME & GEOMETRICS
        VOLUMES      # OF LANES     LANE WIDTH     CROSS
 IR LT    TH   RT    LT TH RT      LT   TH   RT    WALK
 B  139   31  446     0  2  0     0.0 10.0  0.0     0
 B    0    0    0     0  0  0     0.0  0.0  0.0     0
 B    0  954   75     0  3  0     0.0 10.0  0.0     0
 B  103 1322    0     0  3  0     0.0 10.0  0.0     0

 RAFFIC & ROADWAY CONDITIONS
                 ADJ PARK              PEDESTRIANS        ARR
 IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
 B  0.0%  2.0%   Y    10     0   .900    0   N     7.0    3
 B  0.0%  0.0%         0     0   .000    0         7.0    0
 B  0.0%  2.0%   Y    10     0   .900    0   N     7.0    4
 B  0.0%  2.0%   N     0     0   .900    0   N     7.0    5

 HASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                             *  *     *  *        57.9   4    A
 2  *  *  *                                         32.1   4    A

 YCLE=  98.0

)LUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
 IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
 3   139   31  446  .900   154   34  496
 3     0    0    0  .000     0    0    0
 3     0  954   75  .900     0 1060   83
 3   103 1322    0  .900   114 1469    0

 ART 2 (LANE GROUP ADJUSTMENTS)
 IR LN GROUP  FLOW N   LU    v  Plt  Prt
 3  LT-TH-RT   684 2 1.05  719 0.23 0.72
 3  TH-RT     1143 3 1.10 1258 0.00 0.07
 3  LT-TH     1583 3 1.10 1742 0.07 0.00

 ART 3 (OPPOSING VOLUME ADJUSTMENTS)
:FT TURN                 OPPOSING APPROACH
:ING OPPOSED        VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                 LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
 ASTBOUND         0    0    0         0    0    0        0   0   0       0
  UTHBOUND        0 1060   83       100  100  100        0   3   0    1143

:TURATION FLOW ADJUSTMENT WORKSHEET
  R LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt     s
    LT-TH-RT  1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.891 1.000 2467
    TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.989 1.000 4218
    LT-TH     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.739 3318
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SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N    Va   Vm   Vlt  Plt No    Vo Plto
SB  98  58  3 1583 1399  114 0.07  3 1143 0.00
CALCULATIONS
DIR Sop     Yo     Gu     Fs     Pl     Gq     Pt      Gf        El     Fm    Flt
SB 5400 0.212 47.095 0.160 0.766 10.778 0.234  0.610    7.013 0.217 0.739

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT-TH-RT  719 2467 0.29 0.33  809 0.89     *
NB  TH-RT    1258 4218 0.30 0.59 2491 0.50
SB  LT-TH    1742 3318 0.52 0.59 1960 0.89     *

CYCLE= 98.0  LOST= 8.0  SUM V/S CRIT= 0.82 TOTAL V/C= 0.89

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 0.89 0.33  98.0  23.74  809    8.43 0.85   27.34  D  12.5
NB  TH-RT    0.50 0.59  98.0   8.90 2491    0.14 0.62    5.60  B  12.7
SB  LT-TH    0.89 0.59  98.0  13.14 1960    3.94 0.55    9.41  B  17.6

DIR Delay LOS
EB  27.34  D
NB   5.60  B
SB   9.41  B
INTERSECTION DELAY = 11.59 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  98  TO  98 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  98.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  56.8 SECONDS
THE EXISTING TIMING IS OPTIMAL
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE WB
M BUILD ALT #2 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990             time:08:50:57
AST DATA SET NAMES LOADED OR SAVED
OLUME=I4PMBDA2   GEOMETRICS=INT4BTD    SIGNAL=I4PMB2SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B  114   60  378     0  2  0     0.0 10.0  0.0     0
B    0    0    0     0  0  0     0.0  0.0  0.0     0
B    0  972  180     0  3  0     0.0 10.0  0.0     0
B  131 1307    0     0  3  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    3
B  0.0%  0.0%         0    0   .000    0         7.0    0
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    4
B  0.0%  2.0%   N     0    0   .900    0   N     7.0    5

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
1                             *  *     *  *        57.9   4    A
2  *  *  *                                         27.1   4    A

YCLE=  93.0

LUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
B   114   60  378  .900   127   67  420
B     0    0    0  .000     0    0    0
B     0  972  180  .900     0 1080  200
B   131 1307    0  .900   146 1452    0

ART 2 (LANE GROUP ADJUSTMENTS)
 R LN GROUP   FLOW N   LU     v  Plt  Prt
   LT-TH-RT   613 2 1.05  644 0.21 0.68
   TH-RT     1280 3 1.10 1408 0.00 0.16
   LT-TH     1598 3 1.10 1758 0.09 0.00

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
 FT TURN                OPPOSING APPROACH
 ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT        LT  TH  RT     VOLUME
 STBOUND         0    0    0         0    0    0        0   0   0       0
 UTHBOUND        0 1080  200       100  100  100        0   3   0    1280

TURATION FLOW ADJUSTMENT WORKSHEET
 R LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
   LT-TH-RT   1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.897 1.000 2484
   TH-RT      1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.977 1.000 4165
   LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.708 3178
```

```
SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C    G   N   Va    Vm   Vlt  Plt No    Vo Plto
SB  93   58   3 1598 1399   146 0.09  3 1280 0.00
CALCULATIONS
DIR Sop     Yo      Gu     Fs     Pl      Gq     Pt      Gf         El     Fm    Flt
SB 5400 0.237 46.995 0.075 1.000 10.905 0.000  0.000   15.000 0.123 0.708

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP     v     s  v/s  g/C     c  v/c  CRITICAL
EB  LT-TH-RT  644 2484 0.26 0.29  724 0.89     *
NB  TH-RT    1408 4165 0.34 0.62 2593 0.54
SB  LT-TH    1758 3178 0.55 0.62 1979 0.89     *

CYCLE= 93.0  LOST= 8.0  SUM V/S CRIT= 0.81 TOTAL V/C= 0.89

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C      d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 0.89 0.29  93.0  23.96  724    9.34 0.85   28.30  D   11.2
NB  TH-RT    0.54 0.62  93.0   7.60 2593    0.19 0.62    4.83  A   12.5
SB  LT-TH    0.89 0.62  93.0  11.26 1979    3.89 0.55    8.34  B   15.6

DIR Delay LOS
EB  28.30  D
NB   4.83  A
SB   8.34  B
INTERSECTION DELAY = 10.42 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  93  TO  93 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  93.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  55.2 SECONDS
for chosen cycle length  93.0
suggested timing phase 1 is  57.9 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  27.1 secs green,   4.0 secs yellow + red clear
```

```
INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE WB
AT BUILD ALT #2 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990             time:08:52:59
AST DATA SET NAMES LOADED OR SAVED
OLUME=I4SABDA2   GEOMETRICS=INT4BTD    SIGNAL=I4SAB2SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B   91   51  297     0  2  0     0.0 10.0  0.0      0
B    0    0    0     0  0  0     0.0  0.0  0.0      0
B    0  817  151     0  3  0     0.0 10.0  0.0      0
B  110 1102    0     0  3  0     0.0 10.0  0.0      0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    3
B  0.0%  0.0%         0    0   .000    0         7.0    0
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    4
B  0.0%  2.0%   N     0    0   .900    0   N     7.0    5

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                              *  *     *  *        59.3   4    A
   *  *  *                                         27.7   4    A

 CLE=  95.0

 LUME ADJUSTMENT WORKSHEET
 RT 1 (MOVEMENT ADJUSTMENTS)
 R  LTV  THV  RTV   PHF  LTFR THFR RTFR
     91   51  297  .900   101   57  330
      0    0    0  .000     0    0    0
      0  817  151  .900     0  908  168
    110 1102    0  .900   122 1224    0

 RT 2 (LANE GROUP ADJUSTMENTS)
 R LN GROUP   FLOW N    LU     v  Plt  Prt
   LT-TH-RT    488 2 1.05  512 0.21 0.68
   TH-RT      1076 3 1.10 1183 0.00 0.16
   LT-TH      1347 3 1.10 1481 0.09 0.00

 RT 3 (OPPOSING VOLUME ADJUSTMENTS)
 FT TURN                OPPOSING APPROACH
 ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES      OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT     VOLUME
 STBOUND         0    0    0         0    0    0        0   0   0        0
 UTHBOUND        0  908  168       100  100  100        0   3   0     1076

 TURATION FLOW ADJUSTMENT WORKSHEET
 R LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
   LT-TH-RT   1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.899 1.000 2487
   TH-RT      1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.977 1.000 4165
   LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.749 3366
```

```
SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
SB  95  59  3 1347 1347  122 0.09  3 1076 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
SB 5400 0.199 50.366 0.203 0.822  8.890 0.178  0.433    5.548 0.248 0.749

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c v/c   CRITICAL
EB  LT-TH-RT  512 2487 0.21 0.29  726 0.71     *
NB  TH-RT    1183 4165 0.28 0.62 2598 0.46
SB  LT-TH    1481 3366 0.44 0.62 2099 0.71     *

CYCLE= 95.0  LOST= 8.0  SUM V/S CRIT= 0.65 TOTAL V/C= 0.71

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C      d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 0.71 0.29  95.0  22.79  726    2.17 0.85   21.21  C   9.1
NB  TH-RT    0.46 0.62  95.0   7.14 2598    0.09 0.62    4.48  A  10.7
SB  LT-TH    0.71 0.62  95.0   9.13 2099    0.78 0.46    4.52  A  13.4

DIR Delay LOS
EB  21.21  C
NB   4.48  A
SB   4.52  A
INTERSECTION DELAY =  7.20 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  95  TO  95 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  95.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  25.0 SECONDS
for chosen cycle length  95.0
suggested timing phase 1 is  59.3 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  27.7 secs green,   4.0 secs yellow + red clear
```

```
INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE WB
M BUILD ALT #3 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990             time:08:55:11
AST DATA SET NAMES LOADED OR SAVED
OLUME=I4AMBDA3   GEOMETRICS=INT4BTD    SIGNAL=I4AMB3SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B  139   31  437     0  2  0     0.0 10.0  0.0     0
B    0    0    0     0  0  0     0.0  0.0  0.0     0
B    0  954   75     0  3  0     0.0 10.0  0.0     0
3  103 1310    0     0  3  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK                PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
3  0.0%  2.0%   Y    10     0   .900     0   N     7.0    3
3  0.0%  0.0%         0     0   .000     0         7.0    0
3  0.0%  2.0%   Y    10     0   .900     0   N     7.0    4
3  0.0%  2.0%   N     0     0   .900     0   N     7.0    5

IASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
.                             *  *     *  *        58.0   4    A
:  *  *  *                                         32.0   4    A

(CLE=  98.0

)LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
 R  LTV  THV  RTV   PHF  LTFR THFR RTFR
    139   31  437  .900   154   34  486
      0    0    0  .000     0    0    0
      0  954   75  .900     0 1060   83
    103 1310    0  .900   114 1456    0

RT 2 (LANE GROUP ADJUSTMENTS)
 R LN GROUP  FLOW N   LU    v  Plt  Prt
   LT-TH-RT   674 2 1.05  708 0.23 0.72
   TH-RT     1143 3 1.10 1258 0.00 0.07
   LT-TH     1570 3 1.10 1727 0.07 0.00

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                 OPPOSING APPROACH
ING OPPOSED        VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT        LT  TH  RT     VOLUME
STBOUND          0    0    0         0    0    0         0   0   0          0
UTHBOUND         0 1060   83       100  100  100         0   3   0       1143

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
   LT-TH-RT   1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.892 1.000 2469
   TH-RT      1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.989 1.000 4218
   LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.739 3317
```

```
SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
SB  98  58  3 1570 1399  114 0.07  3 1143 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
SB 5400 0.212 47.291 0.160 0.773 10.737 0.227  0.588    7.013 0.216 0.739

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT-TH-RT  708 2469 0.29 0.33  806 0.88     *
NB  TH-RT    1258 4218 0.30 0.59 2498 0.50
SB  LT-TH    1727 3317 0.52 0.59 1964 0.88     *

CYCLE= 98.0  LOST= 8.0  SUM V/S CRIT= 0.81 TOTAL V/C= 0.88

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP v/c   g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 0.88 0.33  98.0  23.70  806    7.78 0.85   26.76  D  12.4
NB  TH-RT    0.50 0.59  98.0   8.83 2498    0.14 0.62    5.56  B  12.7
SB  LT-TH    0.88 0.59  98.0  12.93 1964    3.58 0.55    9.01  B  17.4

DIR Delay LOS
EB  26.76  D
NB   5.56  B
SB   9.01  B
INTERSECTION DELAY = 11.24 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  98  TO  98 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  98.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  53.3 SECONDS
THE EXISTING TIMING IS OPTIMAL
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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE EB
M BUILD ALT #3 W/BTD PROPOSED IMPROVEMETS & SIGNAL OPT
ate:12-05-1990              time:08:57:47
AST DATA SET NAMES LOADED OR SAVED
OLUME=I4PMBDA3   GEOMETRICS=INT4BTD    SIGNAL=I4PMB3SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES       # OF LANES      LANE WIDTH      CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT      WALK
B  110   60  358     0  2  0     0.0 10.0  0.0       0
B    0    0    0     0  0  0     0.0  0.0  0.0       0
B    0  972  180     0  3  0     0.0 10.0  0.0       0
B  131 1310    0     0  3  0     0.0 10.0  0.0       0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK              PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    3
B  0.0%  0.0%         0    0   .000    0         7.0    0
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    4
B  0.0%  2.0%   N     0    0   .900    0   N     7.0    5

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                              *  *     *  *       62.2   4    A
   *  *  *                                        27.8   4    A

CLE=  98.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R   LTV  THV  RTV   PHF  LTFR THFR RTFR
    110   60  358  .900   122   67  398
      0    0    0  .000     0    0    0
      0  972  180  .900     0 1080  200
    131 1310    0  .900   146 1456    0

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N   LU    v  Plt  Prt
  LT-TH-RT    587 2 1.05  616 0.21 0.68
  TH-RT      1280 3 1.10 1408 0.00 0.16
  LT-TH      1601 3 1.10 1761 0.09 0.00

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                OPPOSING APPROACH
ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN     # LANES      OPPOSING
               LT   TH   RT        LT   TH   RT       LT  TH  RT     VOLUME
STBOUND         0    0    0         0    0    0        0   0   0        0
UTHBOUND        0 1080  200       100  100  100        0   3   0     1280

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT-TH-RT  1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.898 1.000 2486
  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.977 1.000 4165
  LT-TH     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.706 3172
```

```
SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
SB  98  62  3 1601 1399  146 0.09  3 1280 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
SB 5400 0.237 51.091 0.075 1.000 11.119 0.000  0.000   15.000 0.119 0.706

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v     s  v/s  g/C    c  v/c  CRITICAL
EB  LT-TH-RT  616 2486 0.25 0.28  705 0.87     *
NB  TH-RT    1408 4165 0.34 0.63 2644 0.53
SB  LT-TH    1761 3172 0.56 0.63 2014 0.87     *

CYCLE= 98.0  LOST= 8.0  SUM V/S CRIT= 0.80 TOTAL V/C= 0.87

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
EB  LT-TH-RT 0.87 0.28  98.0  25.41  705    8.30 0.85   28.65  D  11.4
NB  TH-RT    0.53 0.63  98.0   7.50 2644    0.17 0.62    4.76  A  12.7
SB  LT-TH    0.87 0.63  98.0  11.17 2014    3.33 0.54    7.89  B  15.9

DIR Delay LOS
EB  28.65  D
NB   4.76  A
SB   7.89  B
INTERSECTION DELAY = 10.10 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  98  TO  98 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  98.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  51.7 SECONDS
for chosen cycle length  98.0
suggested timing phase 1 is  62.2 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  27.8 secs green,   4.0 secs yellow + red clear
```

```
INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE WB
AT BUILD ALT #3 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990              time:09:00:29
AST DATA SET NAMES LOADED OR SAVED
OLUME=I4SABDA3   GEOMETRICS=INT4BTD    SIGNAL=I4SAB3SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES        # OF LANES     LANE WIDTH     CROSS
IR  LT    TH    RT     LT TH RT       LT    TH    RT    WALK
B   94    51   314      0  2  0      0.0 10.0  0.0      0
B    0     0     0      0  0  0      0.0  0.0  0.0      0
B    0   817   151      0  3  0      0.0 10.0  0.0      0
B  110  1108     0      0  3  0      0.0 10.0  0.0      0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK                PEDESTRIANS        ARR
IR GRADE %HV    Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  2.0%    Y    10    0   .900    0   N     7.0    3
B  0.0%  0.0%          0    0   .000    0         7.0    0
B  0.0%  2.0%    Y    10    0   .900    0   N     7.0    4
B  0.0%  2.0%    N     0    0   .900    0   N     7.0    5

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
1                              *  *     *  *       57.8   4    A
2  *  *  *                                         28.2   4    A

CLE=  94.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R   LTV  THV  RTV   PHF  LTFR THFR RTFR
     94   51  314  .900   104   57  349
      0    0    0  .000     0    0    0
      0  817  151  .900     0  908  168
    110 1108    0  .900   122 1231    0

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N   LU    v   Plt  Prt
  LT-TH-RT    510 2 1.05  536 0.20 0.68
  TH-RT      1076 3 1.10 1183 0.00 0.16
  LT-TH      1353 3 1.10 1489 0.09 0.00

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                  OPPOSING APPROACH
ING OPPOSED        VOLUMES        % OPPOSING LEFT TURN     # LANES      OPPOSING
                LT   TH   RT        LT   TH   RT        LT  TH  RT     VOLUME
STBOUND          0    0    0         0    0    0         0   0   0        0
UTHBOUND         0  908  168       100  100  100         0   3   0     1076

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP   IDEAL N  Fwid  Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT-TH-RT   1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.897 1.000 2484
  TH-RT      1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.977 1.000 4165
  LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.750 3368
```

```
SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
SB  94  58  3 1353 1353  122 0.09  3 1076 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
SB 5400 0.199 48.782 0.203 0.816  9.006 0.184  0.452    5.548 0.250 0.750

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
EB  LT-TH-RT  536 2484 0.22 0.30  745 0.72     *
NB  TH-RT    1183 4165 0.28 0.61 2561 0.46
SB  LT-TH    1489 3368 0.44 0.61 2071 0.72     *

CYCLE= 94.0  LOST= 8.0  SUM V/S CRIT= 0.66 TOTAL V/C= 0.72

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP v/c   g/C   C     d1    c      d2   PF   Delay LOS  Avg Q  95% Q
EB  LT-TH-RT 0.72 0.30  94.0  22.31  745    2.33 0.85   20.94  C   9.3
NB  TH-RT    0.46 0.61  94.0   7.40 2561    0.10 0.62    4.65  A  10.8
SB  LT-TH    0.72 0.61  94.0   9.50 2071    0.87 0.46    4.81  A  13.6

DIR Delay LOS
EB  20.94  C
NB   4.65  A
SB   4.81  A
INTERSECTION DELAY =  7.45 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  94  TO  94 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  94.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  26.0 SECONDS
for chosen cycle length  94.0
suggested timing phase 1 is  57.8 secs green,    4.0 secs yellow + red clear
suggested timing phase 2 is  28.2 secs green,    4.0 secs yellow + red clear
```

```
CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
MASS AVE @ COMM AVE EB
AM EX
date:05-24-1990             time:07:37:03
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I5AMEX     GEOMETRICS=INT5       SIGNAL=I5AMEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES      # OF LANES     LANE WIDTH     CROSS
DIR  LT    TH    RT    LT TH RT      LT   TH    RT     WALK
EB    0     0     0     0  0  0     0.0  0.0  0.0      0
WB  116    53    69     1  1  0    10.0 10.0  0.0      0
NB    6  1063     0     0  2  0     0.0 10.0  0.0      0
SB    0  1139    58     0  2  0     0.0 10.0  0.0      0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK                PEDESTRIANS         ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF  CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%         0     0  .000    0           7.0     0
WB  0.0%  2.0%   Y    10     0  .900    0   N       7.0     3
NB  0.0%  2.0%   N     0     0  .900    0   N       7.0     5
SB  0.0%  2.0%   Y    10     0  .900    0   N       7.0     4

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                          *  *           *  *     62.0   4    A
 2              *  *  *                             21.0   4    A

CYCLE=  91.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR  LTV  THV  RTV   PHF  LTFR THFR RTFR
EB     0    0    0  .000    0    0    0
WB   116   53   69  .900  129   59   77
NB     6 1063    0  .900    7 1181    0
SB     0 1139   58  .900    0 1266   64

PART 2 (LANE GROUP ADJUSTMENTS)
DIR LN GROUP  FLOW N   LU    v  Plt  Prt
WB  LT         129 1 1.00  129 1.00 0.00
WB  TH-RT      136 1 1.00  136 0.00 0.57
 B  LT-TH     1188 2 1.05 1247 0.01 0.00
 B  TH-RT     1330 2 1.05 1396 0.00 0.05

 ART 3 (OPPOSING VOLUME ADJUSTMENTS)
 EFT TURN                OPPOSING APPROACH
 EING OPPOSED      VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                 LT   TH   RT      LT    TH    RT      LT  TH  RT     VOLUME
 ESTBOUND         0    0    0       0     0     0       0   0   0        0
 ORTHBOUND        0 1266   64     100   100   100       0   2   0     1330

 ATURATION FLOW ADJUSTMENT WORKSHEET
 IR LN GROUP  IDEAL N  Fwid   Fhv    Fgr  Fpark  Fbus  Farea   Frt    Flt     s
 B  LT         1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
 B  TH-RT      1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.915 1.000 1163
 B  LT-TH      1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.768 2299
 B  TH-RT      1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.993 1.000 2748

 UPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
 NPUT VARIABLES
 IR  C   G  N   Va   Vm   Vlt  Plt No   Vo Plto
 B  91  62  2 1188 1188    7 0.01  2 1330 0.00
 ALCULATIONS
```

```
DIR Sop    Yo     Gu     Fs    Pl     Gq     Pt     Gf        El     Fm    Flt
NB 3600 0.369 45.009 0.044 0.059 16.991 0.941 12.846   25.714 0.535 0.768

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C     c  v/c  CRITICAL
WB  LT        129 1422 0.09 0.23  328 0.39
WB  TH-RT     136 1163 0.12 0.23  268 0.51      *
NB  LT-TH    1247 2299 0.54 0.68 1566 0.80      *
SB  TH-RT    1396 2748 0.51 0.68 1872 0.75

CYCLE= 91.0  LOST= 8.0  SUM V/S CRIT= 0.66 TOTAL V/C= 0.72

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1     c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.39 0.23  91.0  22.50  328     0.42 1.00   22.92  C    2.5
WB  TH-RT     0.51 0.23  91.0  23.16  268     1.30 0.85   20.79  C    2.6
NB  LT-TH     0.80 0.68  91.0   7.68 1566     2.09 0.50    4.93  A    9.6
SB  TH-RT     0.75 0.68  91.0   7.14 1872     1.18 0.69    5.73  B   10.7

DIR Delay LOS
WB  21.83  C
NB   4.93  A
SB   5.73  B
INTERSECTION DELAY =  6.85 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  91  TO  91 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  91.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  26.1 SECONDS
for chosen cycle length  91.0
suggested timing phase 1 is  68.3 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  14.7 secs green,   4.0 secs yellow + red clear
```

```
CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
MASS AVE @ COMM AVE EB
PM EX
date:05-30-1990             time:13:03:52
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I5PMEX     GEOMETRICS=INT5       SIGNAL=I5PMEX
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES      # OF LANES     LANE WIDTH     CROSS
DIR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
EB    0    0    0     0  0  0     0.0  0.0  0.0     0
WB  115  236   63     1  1  0    10.0 10.0  0.0     0
NB   26 1026    0     0  2  0     0.0 10.0  0.0     0
SB    0 1245   36     0  2  0     0.0 10.0  0.0     0

TRAFFIC & ROADWAY CONDITIONS
                 ADJ PARK             PEDESTRIANS        ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%          0   0  .000    0          7.0   0
WB  0.0%  2.0%   Y     10   0  .900    0   N      7.0   3
NB  0.0%  2.0%   N      0   0  .900    0   N      7.0   5
SB  0.0%  2.0%   Y     10   0  .900    0   N      7.0   4

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                          *  *           *  *     65.0   4    A
 2              *  *  *                             19.0   4    A

 YCLE=  92.0

 OLUME ADJUSTMENT WORKSHEET
 ART 1 (MOVEMENT ADJUSTMENTS)
 IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
 B      0    0    0  .000     0    0    0
 B    115  236   63  .900   128  262   70
 B     26 1026    0  .900    29 1140    0
 B      0 1245   36  .900     0 1383   40

 ART 2 (LANE GROUP ADJUSTMENTS)
 IR LN GROUP  FLOW N   LU    v  Plt  Prt
 B  LT         128 1 1.00  128 1.00 0.00
 B  TH-RT      332 1 1.00  332 0.00 0.21
 B  LT-TH     1169 2 1.05 1227 0.02 0.00
 B  TH-RT     1423 2 1.05 1495 0.00 0.03

 ART 3 (OPPOSING VOLUME ADJUSTMENTS)
 EFT TURN                OPPOSING APPROACH
 EING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                 LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
 ESTBOUND         0    0    0         0    0    0        0   0   0       0
 ORTHBOUND        0 1383   40       100  100  100        0   2   0    1399

 ATURATION FLOW ADJUSTMENT WORKSHEET
 IR LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
 B  LT        1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
 B  TH-RT     1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.968 1.000 1231
 B  LT-TH     1800  2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.547 1636
 B  TH-RT     1800  2 0.933 0.990 1.000 0.925 1.000 0.900 0.996 1.000 2756

 UPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
 NPUT VARIABLES
 IR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
 B  92  65  2 1169 1169   29 0.02  2 1399 0.00
```

```
CALCULATIONS
DIR Sop    Yo     Gu     Fs     Pl      Gq     Pt      Gf         El     Fm    Flt
NB 3600 0.389 47.838 0.001 0.379 17.162 0.621  3.218 1800.000 0.093 0.547

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP     v     s  v/s  g/C    c  v/c  CRITICAL
WB  LT         128 1422 0.09 0.21  294 0.44
WB  TH-RT      332 1231 0.27 0.21  254 1.31      *
NB  LT-TH     1227 1636 0.75 0.71 1156 1.06      *
SB  TH-RT     1495 2756 0.54 0.71 1947 0.77

CYCLE= 92.0  LOST= 8.0  SUM V/S CRIT= 1.02 TOTAL V/C= 1.12

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.44 0.21  92.0  24.18  294    0.67 1.00   24.86  C   2.6
WB  TH-RT     1.31 0.21  92.0  30.15  254  214.88 0.85  208.28  F  22.6
NB  LT-TH     1.06 0.71  92.0  12.05 1156   38.54 0.63   32.01  D  14.8
SB  TH-RT     0.77 0.71  92.0   6.58 1947    1.34 0.70    5.53  B  10.7

DIR Delay LOS
WB 157.33  F
NB  32.01  D
SB   5.53  B
INTERSECTION DELAY = 37.69 INTERSECTION LOS=D

THE CYCLE LENGTH WITHIN THE BOUNDS OF  92  TO  92 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  92.0 SECONDS

THE V/C RATIO CAN'T BE .95 FOR THE GIVEN CONDITIONS
for chosen cycle length  92.0
suggested timing phase 1 is  61.8 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  22.2 secs green,   4.0 secs yellow + red clear
```

```
INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE EB
AT EX
ate:05-24-1990             time:07:41:04
AST DATA SET NAMES LOADED OR SAVED
OLUME=I5SATEX    GEOMETRICS=INT5       SIGNAL=I5SATEX
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B    0     0   0     0  0  0     0.0  0.0  0.0     0
B   97   198  53     1  1  0    10.0 10.0  0.0     0
B   22   862   0     0  2  0     0.0 10.0  0.0     0
B    0  1046  30     0  2  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%         0    0   .000    0         7.0    0
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    3
B  0.0%  2.0%   N     0    0   .900    0   N     7.0    5
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
1                          *  *           *  *      55.0   4    A
2              *  *  *                              19.0   4    A

YCLE=  82.0

OLUME ADJUSTMENT WORKSHEET
ART 1 (MOVEMENT ADJUSTMENTS)
IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
B     0    0    0  .000     0    0    0
B    97  198   53  .900   108  220   59
B    22  862    0  .900    24  958    0
B     0 1046   30  .900     0 1162   33

ART 2 (LANE GROUP ADJUSTMENTS)
IR LN GROUP  FLOW N   LU     v  Plt  Prt
B  LT          108 1 1.00  108 1.00 0.00
B  TH-RT       279 1 1.00  279 0.00 0.21
B  LT-TH       982 2 1.05 1031 0.02 0.00
B  TH-RT      1196 2 1.05 1255 0.00 0.03

ART 3 (OPPOSING VOLUME ADJUSTMENTS)
EFT TURN                OPPOSING APPROACH
EING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT    VOLUME
ESTBOUND          0    0    0         0    0    0        0   0   0       0
ORTHBOUND         0 1162   33       100  100  100        0   2   0    1196

ATURATION FLOW ADJUSTMENT WORKSHEET
IR LN GROUP IDEAL N   Fwid   Fhv   Fgr Fpark  Fbus Farea  Frt    Flt     s
B  LT         1800 1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
B  TH-RT      1800 1 0.933 0.990 1.000 0.849 1.000 0.900 0.968 1.000 1231
B  LT-TH      1800 2 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.751 2250
B  TH-RT      1800 2 0.933 0.990 1.000 0.925 1.000 0.900 0.996 1.000 2756

UPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
NPUT VARIABLES
IR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
B  82  55  2  982  982   24 0.02  2 1196 0.00
```

```
CALCULATIONS
DIR Sop    Yo     Gu     Fs    Pl     Gq     Pt     Gf       El     Fm    Flt
NB 3600 0.332 41.575 0.128 0.164 13.425 0.836  7.121    8.804 0.503 0.751

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s   g/C    c  v/c  CRITICAL
WB  LT         108 1422 0.08 0.23  330 0.33
WB  TH-RT      279 1231 0.23 0.23  285 0.98     *
NB  LT-TH     1031 2250 0.46 0.67 1509 0.68     *
SB  TH-RT     1255 2756 0.46 0.67 1849 0.68

CYCLE= 82.0  LOST= 8.0  SUM V/S CRIT= 0.68 TOTAL V/C= 0.76

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.33 0.23  82.0  19.90  330    0.22 1.00   20.12  C    1.9
WB  TH-RT    0.98 0.23  82.0  23.78  285   35.29 0.85   50.21  E    6.3
NB  LT-TH    0.68 0.67  82.0   6.24 1509    0.91 0.44    3.18  A    7.4
SB  TH-RT    0.68 0.67  82.0   6.20 1849    0.72 0.66    4.56  A    9.0

DIR Delay LOS
WB  41.82  E
NB   3.18  A
SB   4.56  A
INTERSECTION DELAY =  9.42 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  82  TO  82 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  82.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  28.7 SECONDS
for chosen cycle length  82.0
suggested timing phase 1 is  49.5 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  24.5 secs green,   4.0 secs yellow + red clear
```

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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
\SS AVE @ COMM AVE EB
I NO BUILD W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990              time:10:36:40
\ST DATA SET NAMES LOADED OR SAVED
)LUME=I5AMNB     GEOMETRICS=INT5BTD     SIGNAL=I5AMNB
)CATED IN CBD:Y
)LUME & GEOMETRICS
      VOLUMES        # OF LANES      LANE WIDTH      CROSS
:R  LT    TH    RT    LT TH  RT      LT    TH    RT     WALK
     0     0     0     0  0  0      0.0  0.0   0.0      0
   130    54    70     1  1  0     10.0 10.0   0.0      0
     6  1085     0     0  3  0      0.0 10.0   0.0      0
     0  1279    59     0  3  0      0.0 10.0   0.0      0

:AFFIC & ROADWAY CONDITIONS
                ADJ PARK                PEDESTRIANS        ARR
R GRADE %HV    Y/N MOVES BUSES   PHF CROSS BUT MIN TIME TYPE
  0.0%  0.0%          0     0   .000   0            7.0    0
  0.0%  2.0%    Y    10     0   .900   0    N       7.0    3
  0.0%  2.0%    N     0     0   .900   0    N       7.0    5
  0.0%  2.0%    Y    10     0   .900   0    N       7.0    4

ASINGS
  EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
  l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                          *  *           *  *     70.8   4    A
              *  *  *                             20.2   4    A

CLE=  99.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R   LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0  .000     0    0    0
    130   54   70  .900   144   60   78
      6 1085    0  .900     7 1206    0
      0 1279   59  .900     0 1421   66

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N   LU     v  Plt  Prt
  LT          144 1 1.00   144 1.00 0.00
  TH-RT       138 1 1.00   138 0.00 0.56
  LT-TH      1212 3 1.10  1333 0.01 0.00
  TH-RT      1487 3 1.10  1635 0.00 0.04

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
T TURN                OPPOSING APPROACH
NG OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES     OPPOSING
               LT   TH   RT       LT   TH   RT         LT  TH  RT     VOLUME
TBOUND          0    0    0        0    0    0          0   0   0          0
THBOUND         0 1421   66      100  100  100          0   3   0       1399

URATION FLOW ADJUSTMENT WORKSHEET
 LN GROUP   IDEAL N  Fwid   Fhv    Fgr  Fpark  Fbus  Farea   Frt    Flt     s
 LT          1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
 TH-RT       1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.915 1.000 1163
 LT-TH       1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.706 3169
 TH-RT       1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.993 1.000 4237
```

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SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB  99  71  3 1212 1212    7 0.01  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.259 60.981 0.001 0.177  9.850 0.823  5.733 1800.000 0.117 0.706

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s v/s  g/C     c  v/c  CRITICAL
WB  LT          144 1422 0.10 0.20  290 0.50
WB  TH-RT       138 1163 0.12 0.20  237 0.58     *
NB  LT-TH      1333 3169 0.42 0.72 2267 0.59     *
SB  TH-RT      1635 4237 0.39 0.72 3031 0.54

CYCLE= 99.0  LOST= 8.0  SUM V/S CRIT= 0.54 TOTAL V/C= 0.59

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1     c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.50 0.20  99.0  26.55  290    1.15 1.00   27.70  D    3.2
WB  TH-RT     0.58 0.20  99.0  27.06  237    2.60 0.85   25.21  D    3.0
NB  LT-TH     0.59 0.72  99.0   5.26 2267    0.30 0.40    2.22  A    9.5
SB  TH-RT     0.54 0.72  99.0   4.96 3031    0.16 0.62    3.17  A   11.6

DIR Delay  LOS
WB  26.48  D
NB   2.22  A
SB   3.17  A
INTERSECTION DELAY =  4.81 INTERSECTION LOS=A

THE CYCLE LENGTH WITHIN THE BOUNDS OF  99  TO  99 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  99.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  18.5 SECONDS
for chosen cycle length  99.0
suggested timing phase 1 is  71.0 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  20.0 secs green,   4.0 secs yellow + red clear
```

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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE EB
M NO BUILD W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990             time:09:36:18
AST DATA SET NAMES LOADED OR SAVED
OLUME=I5PMNB     GEOMETRICS=INT5BTD    SIGNAL=I5PMNBSO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B    0    0    0     0  0  0     0.0  0.0  0.0      0
B  121  241   64     1  1  0    10.0 10.0  0.0      0
B   27 1053    0     0  3  0     0.0 10.0  0.0      0
B    0 1314   37     0  3  0     0.0 10.0  0.0      0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%          0    0  .000     0        7.0     0
B  0.0%  2.0%   Y    10    0  .900     0  N     7.0     3
B  0.0%  2.0%   N     0    0  .900     0  N     7.0     5
B  0.0%  2.0%   Y    10    0  .900     0  N     7.0     4

ASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *     52.3   4    A
               *  *  *                             33.7   4    A

CLE=  94.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
 R  LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0  .000     0    0    0
    121  241   64  .900   134  268   71
     27 1053    0  .900    30 1170    0
      0 1314   37  .900     0 1460   41

RT 2 (LANE GROUP ADJUSTMENTS)
 R LN GROUP   FLOW N    LU     v  Plt  Prt
   LT          134 1 1.00  134 1.00 0.00
   TH-RT       339 1 1.00  339 0.00 0.21
   LT-TH      1200 3 1.10 1320 0.03 0.00
   TH-RT      1501 3 1.10 1651 0.00 0.03

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                 OPPOSING APPROACH
ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT         LT   TH   RT       LT  TH  RT    VOLUME
STBOUND          0    0    0          0    0    0        0   0   0        0
RTHBOUND         0 1460   41        100  100  100        0   3   0     1399

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT          1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
  TH-RT       1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.969 1.000 1231
  LT-TH       1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.696 3125
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SB  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.996 1.000 4248

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB  94  52  3 1200 1200   30 0.03  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.259 37.704 0.001 0.603 14.585 0.397  1.315 1800.000 0.087 0.696

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c   CRITICAL
WB  LT        134 1422 0.09 0.36  510 0.26
WB  TH-RT     339 1231 0.28 0.36  441 0.77     *
NB  LT-TH    1320 3125 0.42 0.56 1738 0.76     *
SB  TH-RT    1651 4248 0.39 0.56 2363 0.70

CYCLE= 94.0  LOST= 8.0  SUM V/S CRIT= 0.70 TOTAL V/C= 0.76

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1     c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.26 0.36  94.0  16.23   510    0.07 1.00   16.29  C   2.3
WB  TH-RT    0.77 0.36  94.0  20.28   441    5.47 0.85   21.88  C   5.7
NB  LT-TH    0.76 0.56  94.0  12.18 1738    1.41 0.49    6.59  B  13.9
SB  TH-RT    0.70 0.56  94.0  11.51 2363    0.66 0.67    8.13  B  17.4

DIR Delay LOS
WB  20.30  C
NB   6.59  B
SB   8.13  B
INTERSECTION DELAY =  9.21 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  94  TO  94 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  94.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  30.1 SECONDS
for chosen cycle length  94.0
suggested timing phase 1 is  52.1 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  33.9 secs green,   4.0 secs yellow + red clear
```

```
INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE EB
AT NO BUILD W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990             time:09:39:09
AST DATA SET NAMES LOADED OR SAVED
OLUME=I5SATNB    GEOMETRICS=INT5BTD    SIGNAL=I5SANBSO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
     0    0    0     0  0  0      0.0  0.0  0.0     0
   102  202   54     1  1  0     10.0 10.0  0.0     0
    22  884    0     0  3  0      0.0 10.0  0.0     0
     0 1104   31     0  3  0      0.0 10.0  0.0     0

AFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
R GRADE %HV    Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
  0.0%  0.0%          0    0   .000    0         7.0    0
  0.0%  2.0%    Y    10    0   .900    0   N     7.0    3
  0.0%  2.0%    N     0    0   .900    0   N     7.0    5
  0.0%  2.0%    Y    10    0   .900    0   N     7.0    4

ASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN   Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *     46.9    4    A
               *  *  *                             33.1    4    A

CLE=  88.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R   LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0  .000     0    0    0
    102  202   54  .900   113  224   60
     22  884    0  .900    24  982    0
      0 1104   31  .900     0 1227   34

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP  FLOW N   LU    v  Plt  Prt
  LT          113 1 1.00  113 1.00 0.00
  TH-RT       284 1 1.00  284 0.00 0.21
  LT-TH      1007 3 1.10 1107 0.02 0.00
  TH-RT      1261 3 1.10 1387 0.00 0.03

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                OPPOSING APPROACH
ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN     # LANES     OPPOSING
               LT   TH   RT        LT   TH   RT        LT  TH  RT    VOLUME
STBOUND         0    0    0         0    0    0         0   0   0       0
RTHBOUND        0 1227   34       100  100  100         0   3   0    1261

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT        1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
  TH-RT     1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.968 1.000 1231
  LT-TH     1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.762 3421
```

```
SB  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.996 1.000 4248

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB  88  47  3 1007 1007   24 0.02  3 1261 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.234 34.348 0.087 0.329 12.530 0.671  3.750   12.960 0.285 0.762

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C     c  v/c  CRITICAL
WB  LT        113 1422 0.08 0.38   535 0.21
WB  TH-RT     284 1231 0.23 0.38   463 0.61     *
NB  LT-TH    1107 3421 0.32 0.53  1822 0.61
SB  TH-RT    1387 4248 0.33 0.53  2263 0.61     *

CYCLE= 88.0  LOST= 8.0  SUM V/S CRIT= 0.56 TOTAL V/C= 0.61

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.21 0.38  88.0  14.13  535    0.03 1.00   14.16  B   1.7
WB  TH-RT    0.61 0.38  88.0  16.91  463    1.73 0.85   15.85  C   4.3
NB  LT-TH    0.61 0.53  88.0  10.80 1822    0.43 0.40    4.52  A  11.5
SB  TH-RT    0.61 0.53  88.0  10.84 2263    0.36 0.63    7.02  B  14.4

DIR Delay LOS
WB  15.37  C
NB   4.52  A
SB   7.02  B
INTERSECTION DELAY =  7.21 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  88  TO  88 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  88.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  19.4 SECONDS
for chosen cycle length  88.0
suggested timing phase 1 is  46.8 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  33.2 secs green,   4.0 secs yellow + red clear
```

```
INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE EB
M BUILD ALT #2 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT.
ate:12-05-1990             time:09:40:47
AST DATA SET NAMES LOADED OR SAVED
OLUME=I5AMBDA2   GEOMETRICS=INT5BTD    SIGNAL=I5AMB2SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B    0    0    0     0  0  0     0.0  0.0  0.0     0
B  139   54   70     1  1  0    10.0 10.0  0.0     0
B    6 1086    0     0  3  0     0.0 10.0  0.0     0
B    0 1286   59     0  3  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%         0    0   .000    0         7.0    0
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    3
B  0.0%  2.0%   N     0    0   .900    0   N     7.0    5
B  0.0%  2.0%   Y    10    0   .900    0   N     7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *     70.8   4    A
               *  *  *                             20.2   4    A

 CLE=  99.0

 LUME ADJUSTMENT WORKSHEET
 RT 1 (MOVEMENT ADJUSTMENTS)
 R  LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0  .000     0    0    0
    139   54   70  .900   154   60   78
      6 1086    0  .900     7 1207    0
      0 1286   59  .900     0 1429   66

 RT 2 (LANE GROUP ADJUSTMENTS)
 R LN GROUP  FLOW N   LU    v  Plt  Prt
   LT         154 1 1.00  154 1.00 0.00
   TH-RT      138 1 1.00  138 0.00 0.56
   LT-TH     1213 3 1.10 1335 0.01 0.00
   TH-RT     1494 3 1.10 1644 0.00 0.04

 RT 3 (OPPOSING VOLUME ADJUSTMENTS)
 FT TURN                OPPOSING APPROACH
 ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH   RT        LT   TH   RT       LT  TH  RT     VOLUME
 STBOUND         0    0    0         0    0    0        0   0   0        0
 RTHBOUND        0 1429   66       100  100  100        0   3   0     1399

 TURATION FLOW ADJUSTMENT WORKSHEET
 R LN GROUP  IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt     s
   LT         1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
   TH-RT      1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.915 1.000 1163
   LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.706 3169
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SB  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.993 1.000 4237

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB  99  71  3 1213 1213    7 0.01  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.259 61.000 0.001 0.177  9.845 0.823  5.734 1800.000 0.117 0.706

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s v/s  g/C     c v/c   CRITICAL
WB  LT        154 1422 0.11 0.20  290 0.53
WB  TH-RT     138 1163 0.12 0.20  237 0.58     *
NB  LT-TH    1335 3169 0.42 0.72 2268 0.59     *
SB  TH-RT    1644 4237 0.39 0.72 3032 0.54

CYCLE= 99.0  LOST= 8.0  SUM V/S CRIT= 0.54 TOTAL V/C= 0.59

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.53 0.20  99.0  26.77  290    1.51 1.00   28.27  D   3.4
WB  TH-RT    0.58 0.20  99.0  27.07  237    2.61 0.85   25.23  D   3.0
NB  LT-TH    0.59 0.72  99.0   5.26 2268    0.30 0.40    2.22  A   9.5
SB  TH-RT    0.54 0.72  99.0   4.97 3032    0.16 0.62    3.18  A  11.7

DIR Delay LOS
WB  26.84  D
NB   2.22  A
SB   3.18  A
INTERSECTION DELAY =  4.90 INTERSECTION LOS=A

THE CYCLE LENGTH WITHIN THE BOUNDS OF  99  TO  99 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  99.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  18.5 SECONDS
for chosen cycle length  99.0
suggested timing phase 1 is  71.0 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  20.0 secs green,   4.0 secs yellow + red clear
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:INCH PROGRAM VERSION DATE 4-29-1988
.985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
IASS AVE @ COMM AVE EB
'M BUILD ALT #2 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990               time:09:43:28
AST DATA SET NAMES LOADED OR SAVED
OLUME=I5PMBDA2   GEOMETRICS=INT5BTD    SIGNAL=I5PMB2SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES       # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT     WALK
B    0    0    0     0  0  0     0.0  0.0  0.0      0
B  121  241   64     1  1  0    10.0 10.0  0.0      0
B   27 1061    0     0  3  0     0.0 10.0  0.0      0
B    0 1315   37     0  3  0     0.0 10.0  0.0      0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK               PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%          0     0  .000    0          7.0    0
B  0.0%  2.0%   Y     10     0  .900    0   N      7.0    3
B  0.0%  2.0%   N      0     0  .900    0   N      7.0    5
B  0.0%  2.0%   Y     10     0  .900    0   N      7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
l                          *  *           *  *      52.4   4    A
2              *  *  *                              33.6   4    A

YCLE=  94.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
IR  LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0  .000     0    0    0
    121  241   64  .900   134  268   71
     27 1061    0  .900    30 1179    0
      0 1315   37  .900     0 1461   41

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N   LU    v   Plt  Prt
  LT          134 1 1.00  134 1.00 0.00
  TH-RT       339 1 1.00  339 0.00 0.21
  LT-TH      1209 3 1.10 1330 0.02 0.00
  TH-RT      1502 3 1.10 1652 0.00 0.03

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                OPPOSING APPROACH
ING OPPOSED       VOLUMES       % OPPOSING LEFT TURN    # LANES      OPPOSING
                LT   TH   RT       LT   TH   RT       LT  TH  RT     VOLUME
STBOUND          0    0    0        0    0    0        0   0   0          0
RTHBOUND         0 1461   41      100  100  100        0   3   0       1399

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT          1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
  TH-RT       1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.969 1.000 1231
  LT-TH       1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.696 3124
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SB  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.996 1.000 4248

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB  94  52  3 1209 1209   30 0.02  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.259 37.906 0.001 0.600 14.533 0.400  1.331 1800.000 0.087 0.696

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT         134 1422 0.09 0.36  508 0.26
WB  TH-RT      339 1231 0.28 0.36  440 0.77     *
NB  LT-TH     1330 3124 0.43 0.56 1743 0.76     *
SB  TH-RT     1652 4248 0.39 0.56 2370 0.70

CYCLE= 94.0  LOST= 8.0  SUM V/S CRIT= 0.70 TOTAL V/C= 0.77

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.26 0.36  94.0  16.31  508    0.07 1.00   16.38  C    2.3
WB  TH-RT     0.77 0.36  94.0  20.38  440    5.63 0.85   22.11  C    5.7
NB  LT-TH     0.76 0.56  94.0  12.16 1743    1.44 0.49    6.62  B   14.0
SB  TH-RT     0.70 0.56  94.0  11.43 2370    0.65 0.67    8.06  B   17.3

DIR Delay LOS
WB  20.48  C
NB   6.62  B
SB   8.06  B
INTERSECTION DELAY =  9.21 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  94  TO  94 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  94.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  30.5 SECONDS
for chosen cycle length  94.0
suggested timing phase 1 is  52.2 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  33.8 secs green,   4.0 secs yellow + red clear
```

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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE EB
AT BUILD ALT #2 W/PROPOSED BTD IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990              time:09:46:16
AST DATA SET NAMES LOADED OR SAVED
OLUME=I5SABDA2   GEOMETRICS=INT5BTD    SIGNAL=I5SAB2SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES        # OF LANES     LANE WIDTH     CROSS
IR  LT    TH    RT     LT TH  RT       LT    TH    RT     WALK
B    0     0     0      0  0  0       0.0   0.0   0.0      0
B  105   202    54      1  1  0      10.0  10.0   0.0      0
B   22   886     0      0  3  0       0.0  10.0   0.0      0
B    0  1106    31      0  3  0       0.0  10.0   0.0      0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK                  PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%          0     0   .000    0          7.0    0
B  0.0%  2.0%   Y     10     0   .900    0   N      7.0    3
B  0.0%  2.0%   N      0     0   .900    0   N      7.0    5
B  0.0%  2.0%   Y     10     0   .900    0   N      7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *     49.4   4    A
               *  *  *                             34.6   4    A

CLE=  92.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R   LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0  .000     0    0    0
    105  202   54  .900   117  224   60
     22  886    0  .900    24  984    0
      0 1106   31  .900     0 1229   34

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N   LU     v  Plt  Prt
   LT         117 1 1.00  117 1.00 0.00
   TH-RT      284 1 1.00  284 0.00 0.21
   LT-TH     1009 3 1.10 1110 0.02 0.00
   TH-RT     1263 3 1.10 1390 0.00 0.03

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                OPPOSING APPROACH
ING OPPOSED       VOLUMES       % OPPOSING LEFT TURN     # LANES      OPPOSING
               LT    TH    RT       LT    TH    RT       LT  TH  RT     VOLUME
STBOUND         0     0     0        0     0     0        0   0   0         0
RTHBOUND        0  1229    34      100   100   100        0   3   0      1263

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP   IDEAL N  Fwid   Fhv    Fgr  Fpark  Fbus  Farea   Frt    Flt     s
   LT         1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
   TH-RT      1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.968 1.000 1231
   LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.757 3401
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SB  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.996 1.000 4248

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB  92  49  3 1009 1009   24 0.02  3 1263 0.00
CALCULATIONS
DIR Sop    Yo     Gu     Fs     Pl     Gq     Pt     Gf       El     Fm   Flt
NB 5400 0.234 36.356 0.085 0.339 13.018 0.661  3.639   13.171 0.272 0.757

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT         117 1422 0.08 0.38  535 0.22
WB  TH-RT      284 1231 0.23 0.38  463 0.61     *
NB  LT-TH     1110 3401 0.33 0.54 1825 0.61
SB  TH-RT     1390 4248 0.33 0.54 2280 0.61     *

CYCLE= 92.0  LOST= 8.0  SUM V/S CRIT= 0.56 TOTAL V/C= 0.61

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.22 0.38  92.0  14.81  535    0.03 1.00   14.85  B    1.9
WB  TH-RT     0.61 0.38  92.0  17.68  463    1.73 0.85   16.50  C    4.5
NB  LT-TH     0.61 0.54  92.0  11.14 1825    0.43 0.40    4.66  A   11.9
SB  TH-RT     0.61 0.54  92.0  11.15 2280    0.35 0.62    7.19  B   15.0

DIR Delay LOS
WB  16.02  C
NB   4.66  A
SB   7.19  B
INTERSECTION DELAY =  7.44 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  92  TO  92 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  92.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  19.4 SECONDS
for chosen cycle length  92.0
suggested timing phase 1 is  49.2 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  34.8 secs green,   4.0 secs yellow + red clear
```

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INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE EB
M BUILD ALT #3 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
ate:12-05-1990              time:10:38:29
AST DATA SET NAMES LOADED OR SAVED
OLUME=I5AMBDA3   GEOMETRICS=INT5BTD    SIGNAL=I5AMB3SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES       # OF LANES     LANE WIDTH     CROSS
IR  LT    TH    RT    LT TH RT      LT    TH    RT    WALK
B    0     0     0     0  0  0      0.0  0.0  0.0      0
B  132    54    70     1  1  0     10.0 10.0  0.0      0
B    6  1086     0     0  3  0      0.0 10.0  0.0      0
B    0  1281    59     0  3  0      0.0 10.0  0.0      0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK                PEDESTRIANS       ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF  CROSS BUT MIN TIME TYPE
B  0.0%  0.0%          0     0   .000    0          7.0    0
B  0.0%  2.0%   Y     10     0   .900    0   N      7.0    3
B  0.0%  2.0%   N      0     0   .900    0   N      7.0    5
B  0.0%  2.0%   Y     10     0   .900    0   N      7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *     70.8   4    A
               *  *  *                             20.2   4    A

CLE=  99.0

LUME ADJUSTMENT WORKSHEET
RT 1 (MOVEMENT ADJUSTMENTS)
R   LTV  THV   RTV   PHF  LTFR THFR RTFR
      0    0     0  .000     0    0    0
    132   54    70  .900   147   60   78
      6 1086     0  .900     7 1207    0
      0 1281    59  .900     0 1423   66

RT 2 (LANE GROUP ADJUSTMENTS)
R LN GROUP   FLOW N    LU     v   Plt  Prt
  LT           147 1 1.00   147 1.00 0.00
  TH-RT        138 1 1.00   138 0.00 0.56
  LT-TH       1213 3 1.10  1335 0.01 0.00
  TH-RT       1489 3 1.10  1638 0.00 0.04

RT 3 (OPPOSING VOLUME ADJUSTMENTS)
FT TURN                 OPPOSING APPROACH
ING OPPOSED        VOLUMES       % OPPOSING LEFT TURN    # LANES     OPPOSING
               LT   TH    RT        LT    TH    RT        LT  TH  RT     VOLUME
STBOUND         0     0     0         0     0     0        0   0   0        0
RTHBOUND        0  1423    66       100   100   100        0   3   0     1399

TURATION FLOW ADJUSTMENT WORKSHEET
R LN GROUP  IDEAL N  Fwid   Fhv    Fgr Fpark  Fbus Farea   Frt   Flt    s
  LT         1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
  TH-RT      1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.915 1.000 1163
  LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.706 3169
```

```
SB  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.993 1.000 4237

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB  99  71  3 1213 1213    7 0.01  3 1399 0.00
CALCULATIONS
DIR Sop    Yo     Gu     Fs     Pl     Gq    Pt     Gf        El     Fm   Flt
NB 5400 0.259 61.000 0.001 0.177  9.845 0.823  5.734 1800.000 0.117 0.706

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP     v     s  v/s  g/C    c  v/c  CRITICAL
WB  LT         147 1422 0.10 0.20  290 0.51
WB  TH-RT      138 1163 0.12 0.20  237 0.58     *
NB  LT-TH     1335 3169 0.42 0.72 2268 0.59     *
SB  TH-RT     1638 4237 0.39 0.72 3032 0.54

CYCLE= 99.0  LOST= 8.0  SUM V/S CRIT= 0.54 TOTAL V/C= 0.59

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT        0.51 0.20  99.0  26.61  290    1.22 1.00   27.83  D    3.2
WB  TH-RT     0.58 0.20  99.0  27.07  237    2.61 0.85   25.23  D    3.0
NB  LT-TH     0.59 0.72  99.0   5.26 2268    0.30 0.40    2.22  A    9.5
SB  TH-RT     0.54 0.72  99.0   4.96 3032    0.16 0.62    3.17  A   11.6

DIR Delay LOS
WB  26.57  D
NB   2.22  A
SB   3.17  A
INTERSECTION DELAY =  4.83 INTERSECTION LOS=A

THE CYCLE LENGTH WITHIN THE BOUNDS OF  99  TO  99 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  99.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  18.5 SECONDS
for chosen cycle length  99.0
suggested timing phase 1 is  71.0 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  20.0 secs green,   4.0 secs yellow + red clear
```

```
INCH PROGRAM VERSION DATE 4-29-1988
985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
ASS AVE @ COMM AVE EB
M BUILD ALT #3 W/BTD PROPOSED IMPROVEMENTS & SIG OPT
ate:12-05-1990             time:09:49:02
AST DATA SET NAMES LOADED OR SAVED
OLUME=I5PMBDA3   GEOMETRICS=INT5BTD    SIGNAL=I5PMB3SO
OCATED IN CBD:Y
OLUME & GEOMETRICS
       VOLUMES      # OF LANES     LANE WIDTH     CROSS
IR  LT   TH   RT    LT TH RT      LT   TH   RT    WALK
B    0    0    0     0  0  0     0.0  0.0  0.0     0
B  123  241   64     1  1  0    10.0 10.0  0.0     0
B   27 1057    0     0  3  0     0.0 10.0  0.0     0
B    0 1316   37     0  3  0     0.0 10.0  0.0     0

RAFFIC & ROADWAY CONDITIONS
                ADJ PARK             PEDESTRIANS        ARR
IR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
B  0.0%  0.0%          0    0  .000     0           7.0    0
B  0.0%  2.0%   Y    10    0  .900     0   N     7.0    3
B  0.0%  2.0%   N     0    0  .900     0   N     7.0    5
B  0.0%  2.0%   Y    10    0  .900     0   N     7.0    4

HASINGS
   EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
   l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
                           *  *           *  *     52.4   4    A
               *  *  *                             33.6   4    A

 CLE=  94.0

 LUME ADJUSTMENT WORKSHEET
 RT 1 (MOVEMENT ADJUSTMENTS)
 R  LTV  THV  RTV   PHF  LTFR THFR RTFR
      0    0    0 .000     0    0    0
    123  241   64 .900   137  268   71
     27 1057    0 .900    30 1174    0
      0 1316   37 .900     0 1462   41

 RT 2 (LANE GROUP ADJUSTMENTS)
 R LN GROUP  FLOW N   LU    v  Plt  Prt
   LT          137 1 1.00  137 1.00 0.00
   TH-RT       339 1 1.00  339 0.00 0.21
   LT-TH      1204 3 1.10 1325 0.02 0.00
   TH-RT      1503 3 1.10 1654 0.00 0.03

 RT 3 (OPPOSING VOLUME ADJUSTMENTS)
 FT TURN                OPPOSING APPROACH
 ING OPPOSED       VOLUMES      % OPPOSING LEFT TURN    # LANES     OPPOSING
                LT   TH    RT         LT   TH    RT        LT  TH  RT     VOLUME
 STBOUND         0    0    0         0    0    0        0   0   0       0
 RTHBOUND        0 1462   41       100  100  100        0   3   0    1399

 TURATION FLOW ADJUSTMENT WORKSHEET
 R LN GROUP  IDEAL N  Fwid  Fhv    Fgr Fpark  Fbus Farea   Frt   Flt    s
   LT         1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
   TH-RT      1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.969 1.000 1231
   LT-TH      1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.696 3124
```

```
SB  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.996 1.000 4248

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB  94  52  3 1204 1204   30 0.02  3 1399 0.00
CALCULATIONS
DIR Sop    Yo      Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.259 37.805 0.001 0.602 14.559 0.398  1.323 1800.000 0.087 0.696

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT        137 1422 0.10 0.36  509 0.27
WB  TH-RT     339 1231 0.28 0.36  440 0.77     *
NB  LT-TH    1325 3124 0.42 0.56 1741 0.76     *
SB  TH-RT    1654 4248 0.39 0.56 2366 0.70

CYCLE= 94.0  LOST= 8.0  SUM V/S CRIT= 0.70 TOTAL V/C= 0.76

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C   C     d1    c      d2   PF   Delay LOS Avg Q  95% Q
WB  LT       0.27 0.36  94.0  16.30  509    0.07 1.00   16.37  C    2.3
WB  TH-RT    0.77 0.36  94.0  20.33  440    5.55 0.85   22.00  C    5.7
NB  LT-TH    0.76 0.56  94.0  12.17 1741    1.43 0.49    6.61  B   13.9
SB  TH-RT    0.70 0.56  94.0  11.48 2366    0.65 0.67    8.11  B   17.4

DIR Delay LOS
WB  20.38  C
NB   6.61  B
SB   8.11  B
INTERSECTION DELAY =  9.22 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  94  TO  94 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  94.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  30.3 SECONDS
for chosen cycle length  94.0
suggested timing phase 1 is  52.1 secs green,   4.0 secs yellow + red clear
suggested timing phase 2 is  33.9 secs green,   4.0 secs yellow + red clear
```

```
CINCH PROGRAM VERSION DATE 4-29-1988
1985 HCM - CHAPTER 9: SIGNALIZED - OPERATIONAL ANALYSIS
Y
SAT BUILD ALT #3 W/BTD PROPOSED IMPROVEMENTS & SIGNAL OPT
date:12-05-1990                  time:09:50:32
LAST DATA SET NAMES LOADED OR SAVED
VOLUME=I5SABDA3   GEOMETRICS=INT5BTD    SIGNAL=I5SAB3SO
LOCATED IN CBD:Y
VOLUME & GEOMETRICS
        VOLUMES        # OF LANES      LANE WIDTH      CROSS
DIR  LT   TH   RT    LT TH RT       LT    TH    RT     WALK
EB    0    0    0     0  0  0      0.0  0.0  0.0       0
WB  108  202   54     1  1  0     10.0 10.0  0.0       0
NB   22  689    0     0  3  0      0.0 10.0  0.0       0
SB    0 1109   31     0  3  0      0.0 10.0  0.0       0

TRAFFIC & ROADWAY CONDITIONS
                  ADJ PARK                PEDESTRIANS         ARR
DIR GRADE %HV   Y/N MOVES BUSES  PHF CROSS BUT MIN TIME TYPE
EB  0.0%  0.0%         0     0   .000    0           7.0    0
WB  0.0%  2.0%   Y    10     0   .900    0    N      7.0    3
NB  0.0%  2.0%   N     0     0   .900    0    N      7.0    5
SB  0.0%  2.0%   Y    10     0   .900    0    N      7.0    4

PHASINGS
    EASTBOUND   WESTBOUND   NORTHBOUND  SOUTHBOUND GREEN  Y+R PRE/ACT
    l  t  r  p  l  t  r  p  l  t  r  p  l  t  r  p
 1                          *  *              *  *    46.9   4    A
 2              *  *  *                               33.1   4    A

CYCLE=  88.0

VOLUME ADJUSTMENT WORKSHEET
PART 1 (MOVEMENT ADJUSTMENTS)
DIR   LTV  THV  RTV   PHF  LTFR THFR RTFR
EB      0    0    0  .000     0    0    0
WB    108  202   54  .900   120  224   60
NB     22  689    0  .900    24  766    0
SB      0 1109   31  .900     0 1232   34

PART 2 (LANE GROUP ADJUSTMENTS)
DIR LN GROUP   FLOW N    LU     v  Plt  Prt
WB  LT          120 1 1.00  120 1.00 0.00
WB  TH-RT       284 1 1.00  284 0.00 0.21
NB  LT-TH       790 3 1.10  869 0.03 0.00
SB  TH-RT      1267 3 1.10 1393 0.00 0.03

PART 3 (OPPOSING VOLUME ADJUSTMENTS)
LEFT TURN                 OPPOSING APPROACH
BEING OPPOSED        VOLUMES       % OPPOSING LEFT TURN     # LANES      OPPOSING
                  LT   TH   RT       LT   TH   RT        LT  TH  RT      VOLUME
WESTBOUND          0    0    0        0    0    0         0   0   0          0
NORTHBOUND         0 1232   34      100  100  100         0   3   0       1267

ATURATION FLOW ADJUSTMENT WORKSHEET
DIR LN GROUP   IDEAL N  Fwid   Fhv   Fgr Fpark  Fbus Farea   Frt   Flt    s
B   LT          1800  1 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.950 1422
B   TH-RT       1800  1 0.933 0.990 1.000 0.849 1.000 0.900 0.968 1.000 1231
B   LT-TH       1800  3 0.933 0.990 1.000 1.000 1.000 0.900 1.000 0.744 3342
```

```
SB  TH-RT     1800  3 0.933 0.990 1.000 0.950 1.000 0.900 0.996 1.000 4248

SUPPLEMENTAL WORKSHEET FOR LEFT-TURN ADJUSTMENT FACTOR FLT
INPUT VARIABLES
DIR  C   G  N   Va   Vm  Vlt  Plt No   Vo Plto
NB  88  47  3  790  790   24 0.03  3 1267 0.00
CALCULATIONS
DIR Sop    Yo     Gu    Fs    Pl     Gq    Pt     Gf       El    Fm   Flt
NB 5400 0.235 34.348 0.083 0.425 12.585 0.575  2.618   13.500 0.232 0.744

CAPACITY ANALYSIS WORKSHEET
DIR LN GROUP    v    s  v/s  g/C    c  v/c  CRITICAL
WB  LT        120 1422 0.08 0.38  534 0.22
WB  TH-RT     284 1231 0.23 0.38  462 0.62     *
NB  LT-TH     869 3342 0.26 0.53 1782 0.49
SB  TH-RT    1393 4248 0.33 0.53 2265 0.62     *

CYCLE= 88.0  LOST= 8.0  SUM V/S CRIT= 0.56 TOTAL V/C= 0.62

LEVEL OF SERVICE WORKSHEET
DIR LN GROUP  v/c  g/C    C     d1     c      d2   PF  Delay LOS Avg Q  95% Q
WB  LT       0.22 0.38  88.0  14.23  534    0.04 1.00   14.27  B   1.8
WB  TH-RT    0.62 0.38  88.0  16.95  462    1.75 0.85   15.89  C   4.3
NB  LT-TH    0.49 0.53  88.0   9.84 1782    0.17 0.40    4.01  A   9.0
SB  TH-RT    0.62 0.53  88.0  10.84 2265    0.37 0.63    7.03  B  14.4

DIR Delay LOS
WB  15.41  C
NB   4.01  A
SB   7.03  B
INTERSECTION DELAY =  7.32 INTERSECTION LOS=B

THE CYCLE LENGTH WITHIN THE BOUNDS OF  88  TO  88 SECONDS
WHICH MINIMIZES CRITICAL MOVEMENT DELAY IS  88.0 SECONDS

FOR A V/C RATIO OF .95 THE CYCLE SHOULD BE  19.4 SECONDS
THE EXISTING TIMING IS OPTIMAL
```

APPENDIX F

AIR QUALITY MODELING METHODOLOGIES

APPENDIX F
AIR QUALITY MODELING METHODOLOGIES

F.1 Motor Vehicle Emissions

Motor vehicle emissions used in this analysis were generated by the EPA MOBILE4 computer program.* Modeling inputs were based on Department of Environmental Protection (DEP) and BRA recommendations.** Modeling runs used the MOBILE4 default national motor vehicle mix (see Table F-1) and an average December temperature of 30°F. The Massachusetts registration distributions for light duty vehicles, light duty trucks, and heavy duty trucks (see Table F-2) were used for all years. The MOBILE4 default national cold/hot start mix (presented in Table F-3) was used for determining roadway emissions during the peak eight-hour period. A mix with a higher cold start percentage for the rush hour was used to represent the peak one-hour period (see Table F-4). Emission rates are based on peak one-hour and eight-hour travel speeds for vehicles approaching the intersection as estimated from field surveys.

Table F-5 presents the composite free-flow emission rates for the peak one-hour and eight-hour periods. Idle mode emission rates for development of the CAL3QHC linear queuing source strength were calculated by factoring up the MOBILE4 idle mode emissions using a ratio of the LDGV emissions at 20 mph for the 1-hour and 8-hour vehicle operating conditions to LDGV emissions at 20 mph for hot stabilized conditions. These are shown in Table F-6. This adjustment is necessary since idle mode emissions generated by MOBILE4 are based only on hot stabilized conditions.

The effect of the statewide inspection/maintenance (I/M) program was incorporated and included a program implemented in 1983, a 14% stringency level, no mechanic training, an earliest model year of 15 years prior to the analysis year, vehicle type categories of LDGV, LDGT1 and LDGT2, and an idle test with cut points of 1.2% and 220 ppm for CO and HC, respectively. In addition, an anti-tampering program was assumed. Parameters include implementation in 1983, an earliest model year of 1980, vehicle type categories LDGV, LDGT1, and LDGT2, decentralized program, annual inspection, 50% compliance rate, and inspection performed on catalyst and fuel inlet restrictor. The complete MOBILE4 output is found following Table F-6.

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* EPA, User's Guide to MOBILE4: Mobile Source Emissions Factor Model, EPA-AA-TEB-89-01, Ann Arbor, MI, February, 1989.

** Personal Communication, Mr. Richard Mertens, Boston Redevelopment Authority (BRA), June 6, 1990.

F.2 CAL3QHC Model

For each intersection studied and the garage, the EPA CAL3QHC* computer program was used to predict CO concentrations at sensitive receptor locations. The CAL3QHC program utilizes the FHWA CALINE3** computer model combined with a queuing routine to predict impacts from intersections. The CAL3QHC intersection analysis involves the development of queue links at intersections and the subsequent modeling of these with idling emissions. In addition, the model also considers free flow links using composite free flow emission rates. Modeling runs were supplemented by a set of assumptions consistent with DEP requirements which include an ambient air temperature of 30°F, and worst case meteorological conditions of Pasquill-Gifford Class D stability combined with a 1.0 m/s wind speed for peak one-hour and eight-hour periods. Also, a winter mixing height of 850 meters*** was used. These meteorological data are appropriate for a December day during which peak CO concentrations are expected to occur. For each intersection, the full range of wind directions at 10 degree intervals was examined. In addition, a surface roughness (Z_0) of 175 cm (defined by CALINE3 for office surroundings) and settling and deposition velocities of 0.0 cm/s were incorporated.

Traffic data input to the CAL3QHC model included peak hour volumes for the one-hour averaging period. Eight-hour average modeling runs were made using eight-hour volumes, calculated by multiplying an eight-hour to one-hour factor by the peak one-hour traffic data. Peak eight-hour to one-hour factors used were based on other studies in the area. These are as follow:

o	Massachusetts/Newbury	0.81
o	Massachusetts/Commonwealth	0.81
o	Commonwealth/Charlesgate	0.76

CAL3QHC modeling results are provided following the MOBILE4 output.

---

* Parsons Brinkerhoff Quade & Douglas, Inc. "CAL3QHC: Modified Version of USEPA's CAL3Q Program," January, 1989.

** FHWA, CALINE3 - A Versatile Dispersion Model for Predicting Air Pollutant Levels Near Highways and Arterial Streets, FHWA/CA/TL-79/23, November, 1979.

*** Holzworth, G.C., Mixing Heights, Wind Speeds, and Potential for Urban Air Quality Throughout the Contiguous United States, USEPA, AP-101, January, 1972.

F.3 Parking Garage Analysis

A separate analysis was performed to determine the air quality impacts associated with the Harvard Club garage directly at two receptors near the garage. The garage is open and above ground, with no forced air ventilation system. The MOBILE4 and CAL3QHC computer programs were used to determine the impacts of the garage at these receptor sites.

The analysis assumed traffic on all levels of the proposed garage traveling at 5 mph along the vehicle paths in the garage. The CAL3QHC model allows the height of vehicle paths to be input, up to a maximum of 10 meters from base elevation. It also has a depressed roadway algorithm. For the garage analysis, one level was considered depressed (below grade), one level at grade, and the rest above grade. Also included in the analysis was vehicles traveling along the Newbury Street and queuing at the entrance to the Newbury Street. Garage analysis results are provided following the intersection analysis results, at the end of this appendix.

TABLE F-1
NATIONWIDE AVERAGE
MOTOR VEHICLE MIX BY TYPE*

Vehicle Type	Percentage of VMT	
	1990	1994
Light-Duty Gasoline Vehicles (LDGV)	72.0	71.6
Light-Duty Gasoline Trucks		
0-6000 lb GVW** (LDGT1)	12.2	11.8
Over 6000 lb GVW (LDGT2)	8.2	8.2
Heavy-Duty Gasoline Trucks (HDGV)	1.5	1.5
Light-Duty Diesel Vehicles (LDDV)	1.5	2.1
Light-Duty Diesel Trucks (LDDT)	0.4	0.9
Heavy-Duty Diesel Trucks (HDDT)	3.3	3.0
Motorcycles (MC)	1.0	1.0

---

* EPA, User's Guide to MOBILE4: Mobile Source Emissions Factor Model, EPA-AA-TEB-89-01, Ann Arbor, MI, February, 1989.

** Gross vehicle weight.

TABLE F-2
MASSACHUSETTS VEHICLE REGISTRATION DISTRIBUTION

Vehicle Age in Years	PERCENT OF TOTAL VEHICLES			
	LDGV,LDDV	LDGT,LDDT	HDGV	HDDV
1	5.6	7.0	6.5	8.2
2	10.3	9.2	13.1	16.5
3	10.4	8.8	11.3	13.5
4	9.5	8.3	9.7	11.1
5	7.3	7.7	8.4	9.1
6	6.5	7.2	7.2	7.5
7	6.7	6.7	6.2	6.1
8	6.9	6.2	5.4	5.0
9	7.2	5.7	4.6	4.1
10	6.5	5.1	4.0	3.4
11	5.5	4.7	3.4	2.8
12	4.3	4.1	3.0	2.3
13	2.9	3.6	2.6	1.9
14	2.5	3.1	2.2	1.5
15	2.1	2.6	1.9	1.3
16	1.6	2.1	1.6	1.0
17	0.9	1.6	1.4	0.9
18	0.6	1.1	1.2	0.7
19	0.4	0.7	1.0	0.6
20 +	2.4	4.4	5.3	2.9

Source: Massachusetts Department of Environmental Protection

TABLE F-3
NATIONWIDE AVERAGE COLD / HOT START MIX FOR MOTOR VEHICLES

Vehicles Cold Start Mode	20.6%
Vehicles Hot Start Mode	27.3%
Vehicles Hot Stabilized Mode	52.1%
TOTAL	100.0%

TABLE F-4
RUSH HOUR COLD / HOT START MIX FOR MOTOR VEHICLES

Vehicles Cold Start Mode	50.0%
Vehicles Hot Start Mode	10.0%
Vehicles Hot Stabilized Mode	40.0%
TOTAL	100.0%

TABLE F-5
COMPOSITE ONE- AND EIGHT-HOUR CO EMISSION RATES

Roadway	Speed (mph)	CO Emission Rate (grams/minute)			
		1990		1994	
		1-Hour	8-Hour	1-Hour	8-Hour
Parking Garage	5	--	--	106.54	66.39
Access Road	10	--	--	61.35	38.10
Newbury Street	15	64.44	38.92	46.28	28.57
Massachusetts Avenue	18	55.55	33.46	41.25	25.38
Commonwealth Avenue					
East of Mass Avenue	18	55.55	33.46	41.25	25.38
West of Mass Avenue	20	51.44	30.61	39.30	23.59
Underpass	35	29.18	17.35	22.40	13.44

TABLE F-6
IDLE MODE EMISSION RATES

Averaging Period	CO Emission Rate (grams/minute)	
	1990	1994
1-Hour	17.50	13.01
8-Hour	9.98	7.45

5054 009